Iron and Steel ENGINEER

ENGINEERING SERVICE
TO THE IRON AND STEEL
INDUSTRY SINCE 1907

1010 EMPIRE BUILDING | JANUARY, 1943 | PITTSBURGH, PA.

TECHNOLOGY DEPT.
PUBLIC LIBRARY

Pouring Electric Alloy Steel at Mesta

ARMY E NAVY
The Army-Navy "E" Flag, with two stars, flies over the Mesta plant.

MESTA MACHINE COMPANY - PITTSBURGH, PA.

R v.20 Jan.-June 1943

to Speed a Nation's Production

THE giant 77" lifting magnet—the world's largest—is just one of the many types of C-H Supermagnets that are working day in and day out in the nation's leading plants getting today's vital job done.

By utilizing a crane's "reserve" capacity, Supermagnets afford the most economical and immediate method of gaining maximum metal handling production. Supermagnets stand up day after day, year after year, giving unfailing dependability to maintain 24-hour schedules. And at the same time provide, dollar for dollar, the greatest lifting power and efficiency to be had in the lifting magnet field.

Get all the facts about the Cutler-Hammer line of lifting magnets. Watch a Supermagnet at work on a tough job—the tougher the better—then try Supermagnets yourself and get the greater metal-handling speeds, lower operating and demurrage costs they bring. CUTLER-HAMMER, Inc., 1257 St. Paul Avenue, Milwaukee, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

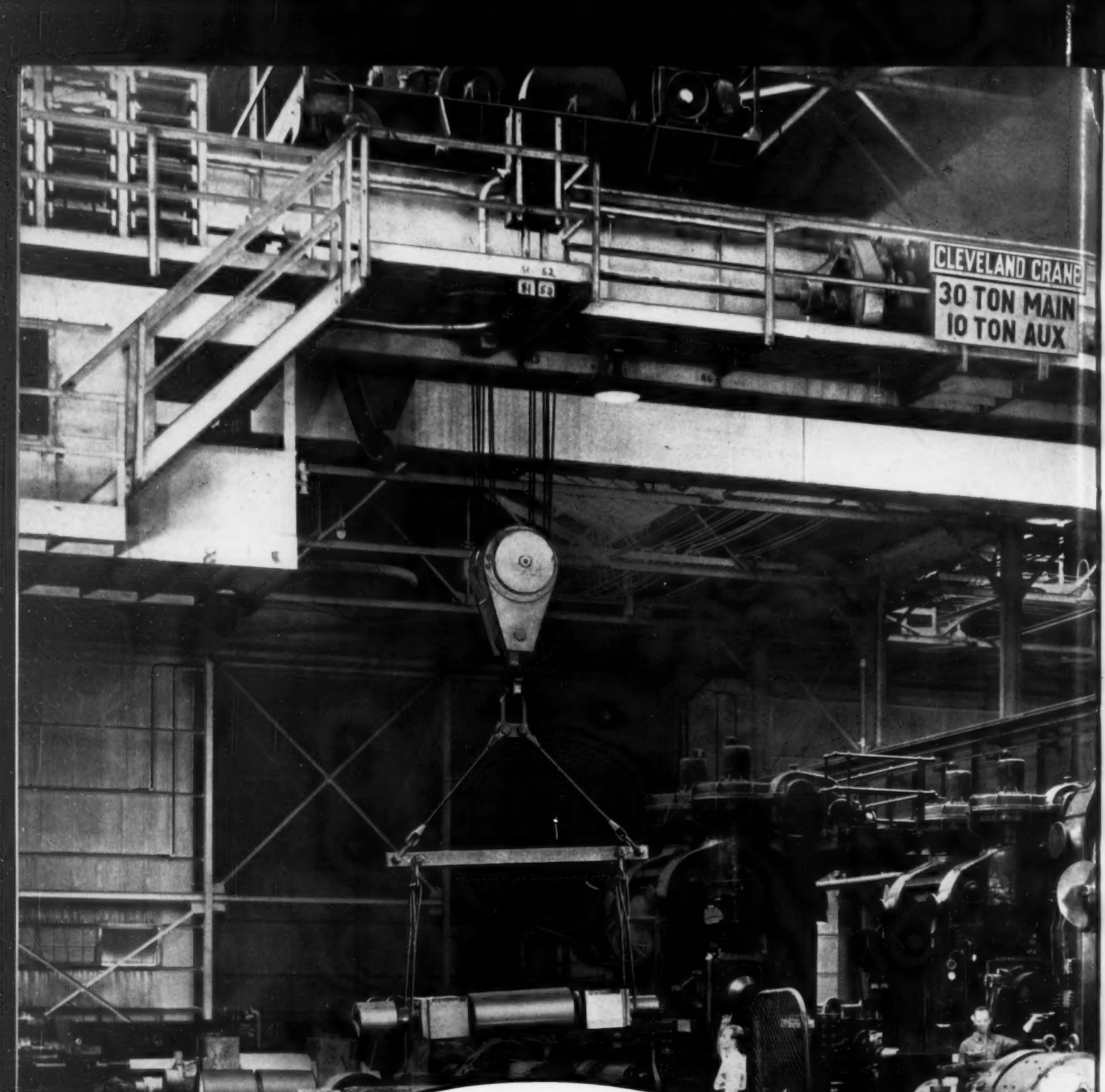
CUTLER-HAMMER
SUPERMAGNETS
C-H

1·9·4·3

AMERICA'S YEAR OF DESTINY

The dismal days of early 1942 are behind us...when defeat followed defeat and a complacent, peaceful America was compelled to adjust to the reality of War. Now the tide gives evidence of turning and the road to Victory and Peace lies clearly ahead. How fast we travel this road depends greatly upon the homefront, our conserving of vital materials and foodstuffs; a unified participation in scrap campaigns; ever increasing, uninterrupted production; War Bond purchases by all . . . . the way has been pointed, let's accept the challenge.

THE AETNA-STANDARD ENGINEERING CO. · YOUNGSTOWN, OHIO
DESIGNERS AND BUILDERS TO THE STEEL, NON-FERROUS AND CHEMICAL INDUSTRIES



In these days when uninterrupted production is so vital for victory, all-welded Cleveland Cranes are giving an excellent account of themselves in many of the nation's leading mills.
The crane illustrated has a span of 80 feet and serves the Temper Mill Tin Plate Division of one of the world's largest steel mills.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

THE critical scrap situation of last spring, when steel plant scrap inventories showed only 1,794,000 tons (about 2 weeks supply) on hand, has been definitely improved by the nation-wide scrap drive. Recent inventories show 3 to 4 weeks supply on hand, and scrap dealers' inventories are higher. This does not mean, however, that collection efforts may be relaxed — on the contrary, such efforts must continue under full steam if ingot production is to be maintained. A valuable by-product of the scrap drive is the amount of material which is salvaged by ingenious maintenance men for use in repairing equipment which would otherwise be held up for want of repair parts.

▲

TO the accompaniment of rattling skeletons as old iron masters and puddlers turned in their graves, attractive lounge quarters have been set up in virtually all steel plants to accommodate the many women entering the industry's employ. Among the jobs taken over by the distaff side are weighmasters, messengers, clerks, chemists, recorders, welders, scarfers, machine operators, observers, crane operators and followers, mill operators, etc. Reports indicate that the girls are doing a splendid job. It's going to be hard for the men after the war when they try to get away with how tough the job is and how tired they are.

▲

COMES a letter from the manager of a large English steel plant: "All of the boys are now receiving copies of the Iron and Steel Engineer in the regular manner and are finding them extremely useful. I do hope that the government will allow these magazines to come on through as I am sure they are of benefit to the war effort of both the U. S. A. and the United Kingdom".

The letter further states that hot strip production in this plant has been materially assisted by the supply of slaps shipped from America. That plant alterations are continued even under war conditions is indicated by the fact that a finishing stand is being added on the hot strip mill.

▲

STATISTICS on the 1941-42 National Safety Council's Metals Section safety contest show that steel mills held their accident frequency rate even with the previous year at 4.81. In view of the large numbers of new employees in the industry, this record bespeaks volumes on the fine work accomplished by the plants in breaking in the new employees and in carrying on the intensified safety drive to conserve man-power.

In this connection we note that glamour goes by the boards with the female replacements. Safety rules prescribe shoes with hard toes and sensible heels. Permanent waves are covered by caps or turbans A ray of hope, however, comes from one manufacturer who is streamlining the graceless coverall jumper into something a bit more feminine.

▲

THE second Victory Book Campaign, running from January 5th to March 5th, 1943, is attempting to collect millions of books for distribution to our armed forces. The material desired includes current best sellers; popular fiction and non-fiction published since 1930; adventure, western, detective and mystery fiction; humorous books; pocket-sized editions of popular titles; and technical books published since 1935.

Books thus distributed do much to entertain our services, and are a great source of information and morale. Collection points have been scattered nation-wide. Go over your own shelves — but remember, any book you give should be in good physical shape and one you would really like to keep.

▲

BITUMINOUS coal requirements for 1943 have been projected at 600,000,000 tons to carry out planned operations and to meet essential civilian requirements. This is the greatest quantity the mines have ever been asked to produce, and represents a considerable increase over the 1942 production of 560,000,000 tons. Included in the requirements are 126,000,000 tons of coal for steam and coking in the iron and steel industry. Public utilities will require coal for an estimated generation of 136 billion kilowatt hours from steam-electric plants. Railroad consumption may be 10 per cent above 1942, and the conversion from fuel oil to coal is expected to raise the consumption for domestic heating and other uses by at least 3,000,000 tons.

▲

AS 1942 moved to its finish, rowboats plying around the lower end of Pittsburgh's triangle brought ugly memories of 1936 with its flood crest of 46.2 ft. Although almost ten feet lower than 1936, the crest of December 30-31 occasioned numerous shut-downs and production losses in the plants along the Monongahela, Allegheny, Ohio and tributary valleys. Reports from other parts of the country also show some shut-downs due to high water. Even beyond the actual shut-down periods, production was further hindered by wet flues and checker chambers after the waters receded.

The unfortunate alliance of Old Man River with Mr. Schickelgruber brought some calls for reprints from the Iron and Steel Engineer of December, 1937, on "Flood Protection and Rehabilitation", containing data developed following the 1936 flood.

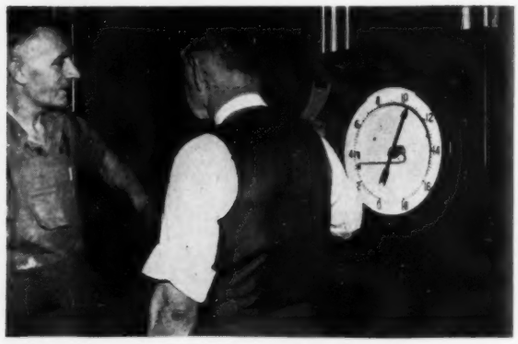
Foreman checks hardening temperature by glance at the furnace's Micromax Controller.

MAKING MACHINE GUNS With Help of Micromax Pyrometers

The control of temperatures in such heat-treating operations as homogenizing, normalizing, hardening, cyaniding, annealing, tempering, etc., is handled on scores of furnaces by Micromax Pyrometers in the vast machine-gun works of John Inglis Co. Ltd., Toronto. Tens of thousands of Colt Browning, Brens and Boys guns are leaving the Inglis plant, heat-treated by operations such as these:

Cyaniding: Pot furnaces are arranged on both sides of a central aisle. Each has a Micromax Controller right alongside, where the operator can always see it. Some of these Controllers are round-chart and others strip-chart; some use on-off control and others require full-floating, proportioning Micromax Electric Control. In any case, control is fully automatic and the Controller's micro-responsiveness and dependability help the operator to do a good job, and show the foreman its quality.

Homogenizing or grain-refining: Rough-forged gun barrels are heated in oil-fired furnaces and quenched in revolving-fixture machines, to refine the grain before being Homo-annealed, rough-turned and bored. Furnace operators are on the jump, loading the furnace and the quench machine; they never give a thought to temperature control of the furnace. But the foreman has only to set the strip-chart Micromax, and it faithfully carries out his orders. . . . Furnaces for gun-frame forgings discharge these parts directly into a quench tank. Operators thus never see the hot forgings, and so have no occasion at all for concern about furnace heat; but again the Controllers maintain temperature as "instructed" by the foreman.



Foreman and heat-treater consult Round-Chart Micromax Controller before changing charge in cyaniding pot.

This ability of a Micromax Pyrometer to carry on without attention is principally due to its automatic and semi-automatic self-servicing features. It standardizes its own measuring circuit; shows a warning if its electric power is cut off; signals far in advance of its infrequent needs for ink, chart and dry batteries. Its record is extremely easy to read.

For information about ranges, models, etc., see Catalog N-33A, Micromax Thermocouple Pyrometers, or N-33B, Micromax Rayotube Pyrometers.

Micromax Controllers for a huge annealing furnace.

Jrl Ad N-33-620(3)

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

STEPPING STONES TO VICTORY!

EACH landing we make, each enemy position we capture is a stepping stone toward Victory. Each is part of a great chain, leading to Berlin, Rome, and Tokio. But remember, the men who tread this path need backing from all of us at home.

For example, strict conservation of batteries is vitally important . . . and the four simple rules for battery care may be compared to stepping stones. Follow them to make batteries last. Buy to last and save to win.

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

FIRST STEPPING STONE—Keep adding approved water at regular intervals. Most kinds of local water are safe in an Exide Battery. Ask us if yours is safe.

SECOND STEPPING STONE—Keep the top of the battery and battery container clean and dry at all times. This will assure maximum protection of the inner parts.

THIRD STEPPING STONE—Keep the battery fully charged—but avoid excessive overcharge. There's always a right way to do any job and a storage battery will last longer when charged at its proper voltage.

FOURTH STEPPING STONE—Keep records of water additions, voltage, and gravity readings. Don't trust your memory. Write down a complete record of your battery's life history. Know what's happening!

If you wish more detailed information, or have a special battery problem, don't hesitate to write to Exide. We want you to get the long-life built into every Exide Battery. Ask for Booklet Form 1982.

Exide
IRONCLAD
BATTERIES

HERE'S A *Grid Design* THAT'S DIFFERENT!

DIFFERENT—because the unique design of the P-G Steel Grid insures even heat distribution over the entire grid surface. Each part of the resistor element is equally exposed to air. Heat produced is rapidly dissipated and resistor can be overloaded without damage or developing hot spots. Where trouble-free, heavy duty service is desired, specify P-G . . . . .

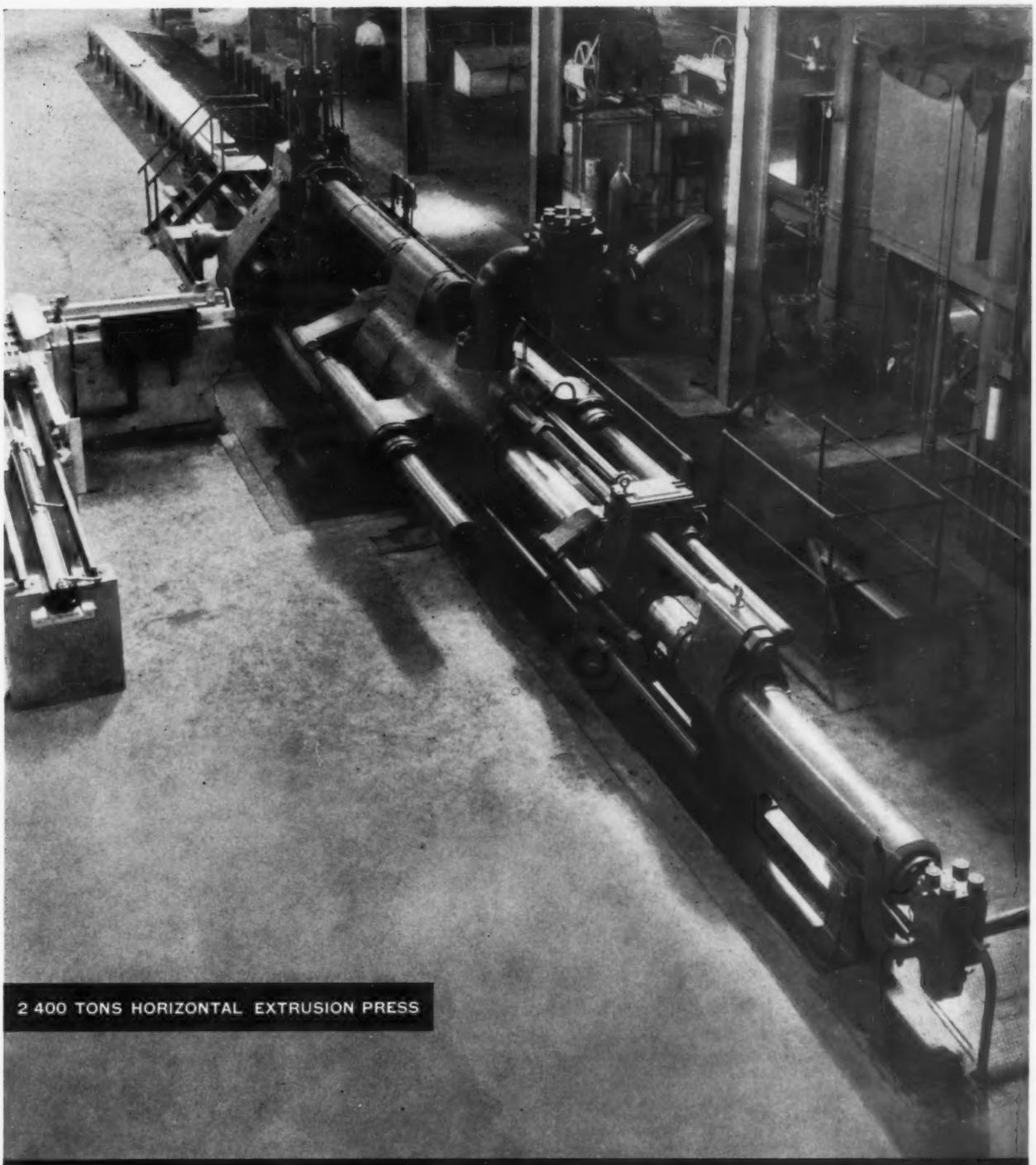
P-G

"The Resistor you can Install and Forget"

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI, OHIO



HYDROPRESS · INC.

ENGINEERS CONTRACTORS

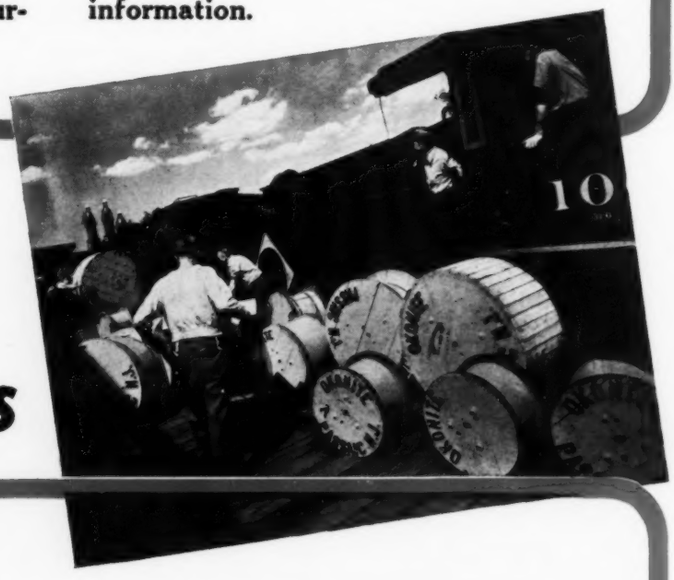
HYDRAULIC PRESSES · ROLLING MILLS
PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE · NEW YORK · N. Y.

DO:

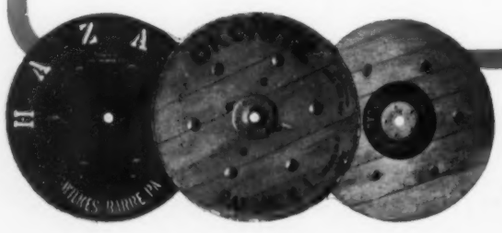
- order your wire requirements as far in advance as possible, to allow time to apply for material allocations from the War Production Board. Consult with government engineers to check with their requirements before purchasing cable for a *governmental financed project.*
- avoid complicated splices and fittings. Your Okonite representative can tell you how to simplify installations.
- supply us with cutting lengths promptly as we cannot start manufacture, in most cases, until we have this information.

To Expedite Shipment of Wires and Cables



DON'T:

- specify cables that are unnecessarily complicated. Each operation on a cable requires special machines, any one of which may be cause of delay. Keep your cable design simple. Consult your Okonite representative as to how you can do this.
- order short lengths of many sizes. Standardization on a few sizes almost always results in lower cost per foot and much quicker delivery.
- send your order in without specifying End Use, conditions of installation, preference rating, priority authorization, army, navy or other governmental contract number, if any. This information is necessary in order to secure permission to manufacture.



3190

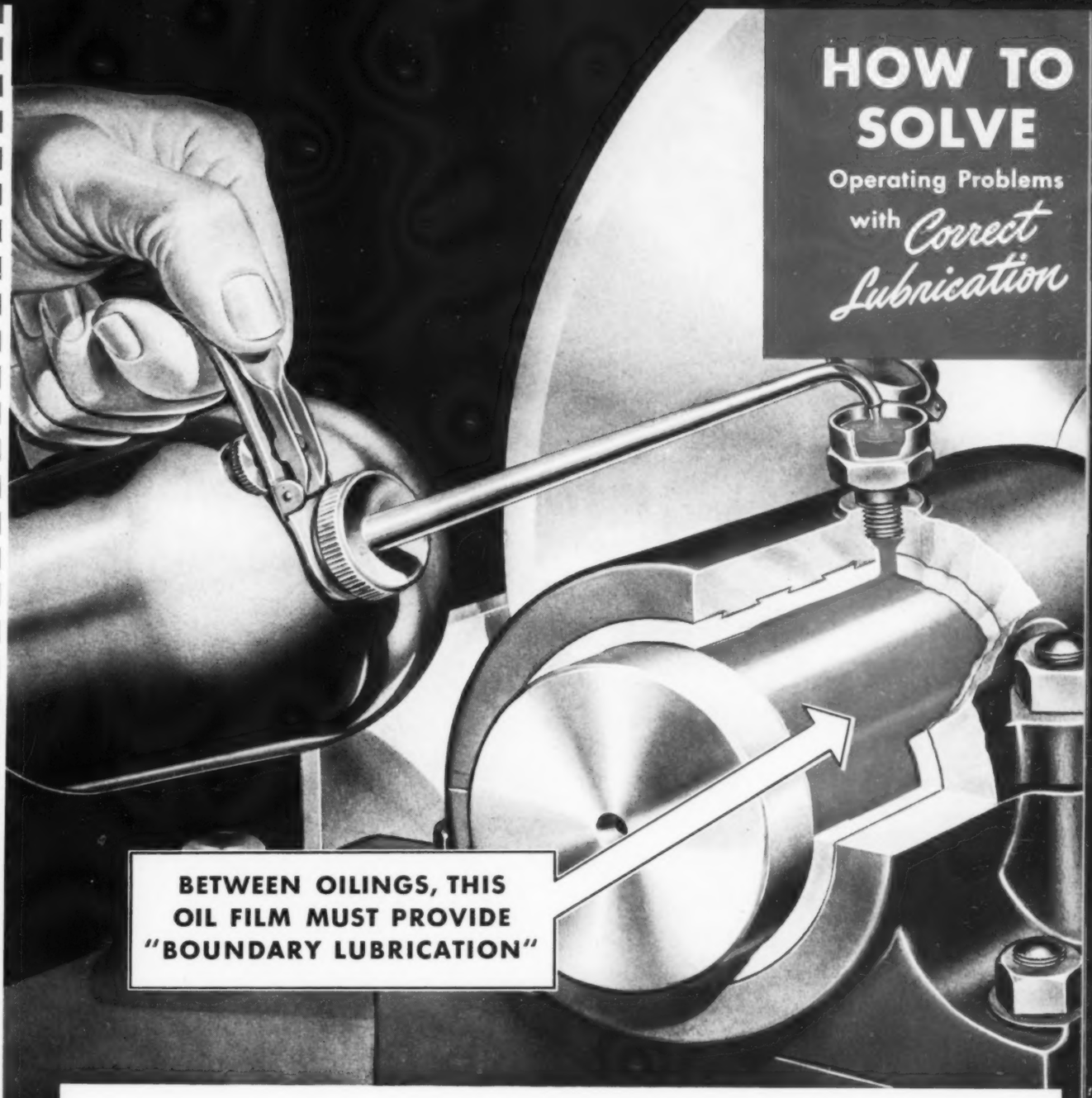
THE OKONITE COMPANY
THE OKONITE-CALLENDER CABLE CO., Incorporated
HAZARD INSULATED WIRE WORKS DIVISION
Executive offices, Passaic, N. J. • Branch offices in principal cities

Salvage Your Scrap — Buy U. S. War Bonds

ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION

HOW TO SOLVE

Operating Problems with *Correct Lubrication*



Save Production Time Here!

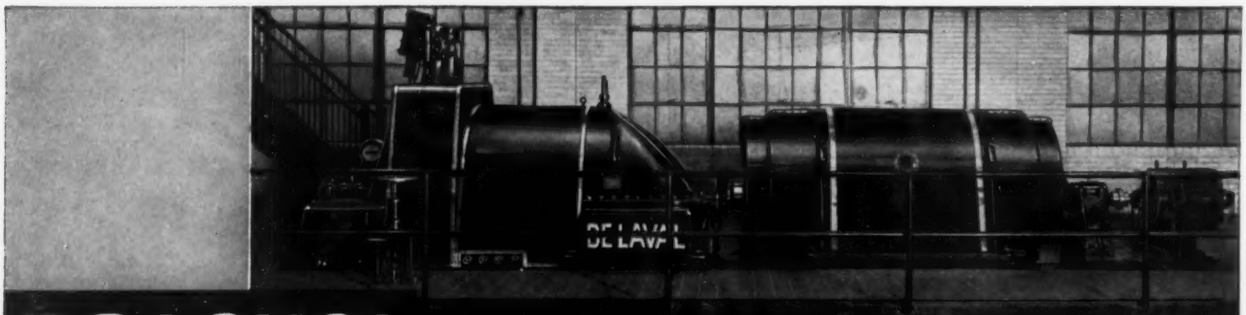
PROBLEM: That red film of oil you see on the journal above is ample—at the time the bearing is oiled. But before the next application, the oil will drain off. Just a tissue-thin film — boundary lubrication — will remain. If you use ordinary mineral oil the film may not stand up. Metal-to-metal contacts between journal and bearing may result. Bearings fail. Important machines stop producing.

ANSWER: There is an oil specially made to meet this problem. It is called Gargoyle Vactra Oil. It has an extremely tenacious, persistent film that resists wiping action and rupture even when a film of microscopic thickness remains. Wear, temperature rise and power consumption are minimized with an extremely small supply of this oil. You are assured dependable operation and economy, too.

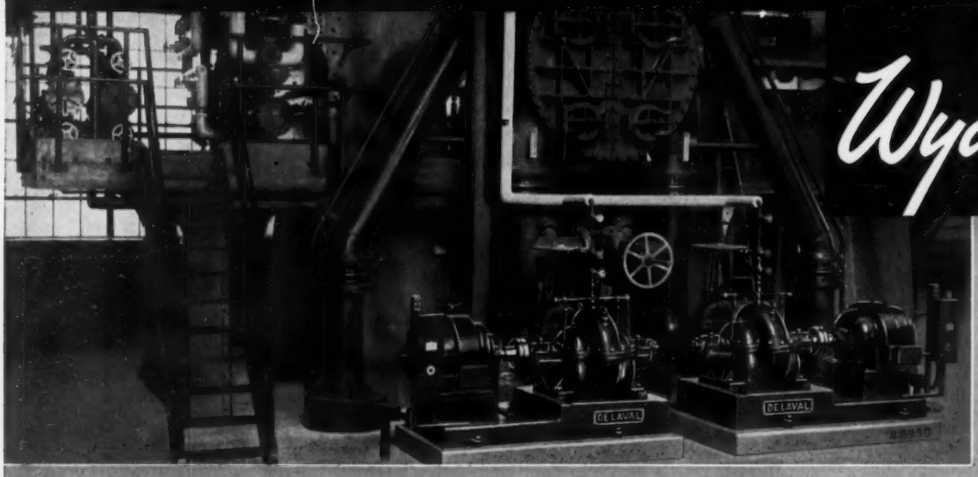
GARGOYLE Lubricants

SOCONY-VACUUM OIL COMPANY, INC.—Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. White Eagle Div. • Wadhams Div. • Southeastern Div. (Baltimore) • Magnolia Petroleum Co. • General Petroleum Corp.

CALL IN SOCONY-VACUUM



DE LAVAL TURBO-ALTERNATOR at Wyandotte



IN 1938, the City of Wyandotte, Mich., placed an order for a De Laval turbo-alternator to generate 4,000 kw. (5,000 kw. maximum) from steam at 425 psi. and 720° F., to be operated condensing, but with bleeder connections for feed heating and for heating the Wyandotte City Hospital. This unit, which has been in continuous service since January, 1940, operates in parallel with an older 2,000 kw. generator and with the power system of the Michigan Alkali Company.

The turbine is of the impulse type, with ample bucket clearances and with provisions to equalize expansion. An accurate and sensitive fly-weight governor controls the admission valves through two stages of hydraulic relay amplification and can be set manually or by the remote synchronizing device. The entire governor mechanism is housed in the turbine base, without exposed piping or mechanism.

Constructional details have been designed for high pressure, high temperature steam, with segregation of moisture in the low pressure stages.

The installation includes De Laval condenser circulating pumps, condensate pumps, boiler feed pumps and lubricating oil purifier. A similar De Laval unit rated at 6,000 kw. has since been ordered.

Further particulars are given in Leaflet T-3521, sent upon request

DE LAVAL Steam Turbine Co.
TRENTON, N. J.

MANUFACTURERS OF TURBINES, STEAM, HYDRAULIC, PUMPS, CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, CLOGLESS, SELF-PRIMING, CENTRIFUGAL BLOWERS and COMPRESSORS, GEARS, WORM, HELICAL, and FLEXIBLE COUPLINGS

Hours Lost Through Accidents. Reduction of lost-time accidents, as everyone knows, is an excellent way to increase war production. If any appreciable number of such accidents results from manual handling of materials, the solution may lie in power trucking—with a big gain in efficiency as a bonus. The safe way is also the efficient way.

Transportation Job. The whole country is admiring the way the railroads are handling their war-time job. But within industry itself, *inside* transportation is performing comparable marvels. Many old plants are producing several times their former capacity per-square-foot and per-work-hour, solely because the *flow* of production and materials has so much improved. To keep production flowing at peak efficiency requires a truck power unit that is not subject to failure on the job—one whose performance is predictable. Another way of saying, "alkaline batteries."

Are You on Our List? Edison's house publication, "Storage Battery Power," is an up-to-the-minute source of authoritative material-handling information. If you're not on our list you can be readily by simply sending us your name and business address.

Edison Storage Battery Division
Thomas A. Edison, Inc.
WEST ORANGE, N. J.

PEAK POWER needed for war

It is true that all power units in material-handling trucks are specifically *rated.* But it's power *delivered* that wins in war production. When the trucks are powered by alkaline batteries they stay on the job, turn out the work expected of them, are not subject to lay-ups for repairs. In many war plants, alkaline batteries are today working much harder than their operators ever expected they would—and are standing up admirably under such peak demands.

All this is not something which just happened. It is the nature of this modern type of power unit. Ruggedness comes from Edison steel-construction, its self-preservation chemical principle, and its foolproof electrical qualities.

INDUSTRY NEEDS THE DEPENDABILITY OF

Edison Alkaline BATTERIES

IS BILLET CHIPPING YOUR BOTTLENECK ?

Chipping time ratio on this 8½" x 10" billet of S.A.E. 1450 Steel was 49 to 1. Billeteer cleaned light portion, at right, in ⅛ time required to hand-chip dark end, at left.

Do you have trouble maintaining an adequate force of billet chippers? Are they unable to keep up with your full billet production?

If billets jam up in your chipping department, you should get the facts on the

BILLETEER

This complete billet chipping unit answers the "call to production" by working 24 hours a day if necessary, and asks no quarter! Turns out thoroughly cleaned billets in record-shattering time (10 to 20 billets while the average chipper is doing one by hand). All operations under finger-tip power control of a single operator.

Billeteers carry a very high priority rating. The demand for this machine prevents our keeping them in stock — so place your order NOW for earliest future delivery.

Send for our descriptive Brochure. It gives information vital to every steel plant engineer and production executive.

The Billeteer cutting head with 8 or 10 tools makes fast work of seams and defects. It cuts away approximately 120 bites a minute.

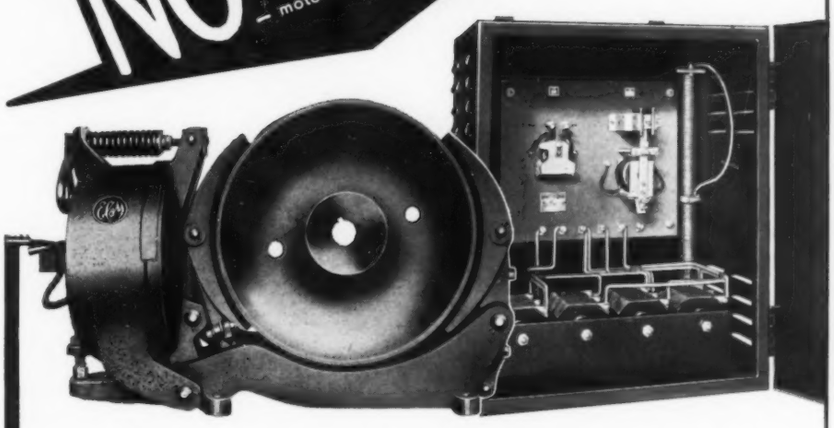
BUILDERS OF BONNOT-LENTZ BILLETEERS ALSO CRUSHING PULVERIZING AND MIXING EQUIPMENT

THE Bonnot COMPANY
STEEL EQUIPMENT DIVISION
CANTON, OHIO

EC&M Presents

The PERFECT SOLUTION to the A-c BRAKE PROBLEM

NO
- laminated magnets or plungers
- destructive hammer-blow
- A-c chatter
- coil burn-out due to shoe-wear affecting air-gap
- motors, gears or pumps



FOR CRANES, HOISTS and MACHINERY

The well known EC&M WB Brake for d-c service is now available for operation on a-c circuits by the addition of a compact rectifier-unit. When used with magnetic control, the rectifier equipment is usually combined with the motor control panel.

This is a proven system of braking with several hundred already in successful operation. It allows high current for *fast release,* reduced holding current to give *fast* brake setting. And has these advantages:—*accurate inching*—has *hand release*—*solid* cast-steel *magnet* and *armature*—*short* armature-*movement*—thick *moulded* brake blocks—and all the advantages of the top-ranking WB Brake for d-c applications.

New Bulletin 1006 gives complete facts on EC&M "WB" Brakes for a-c motors. Write for a copy today.

THE ELECTRIC CONTROLLER & MFG. CO.
2700 EAST 79th STREET CLEVELAND, OHIO

Please send me Bulletin 1006.

Name .....

Company .....

Address .....

Now--BRAKES for A-c & D-c by EC&M

The above alternating current, overhead traveling crane, arranged for operation from the floor, has an EC&M Type WB Brake mounted on the hoist-motor shaft. The rectifier equipment is mounted on the rear of the EC&M, A-c Dynamic Lowering Controller shown on the crane-bridge walkway at the left of the above illustration. (Bulletin 930)

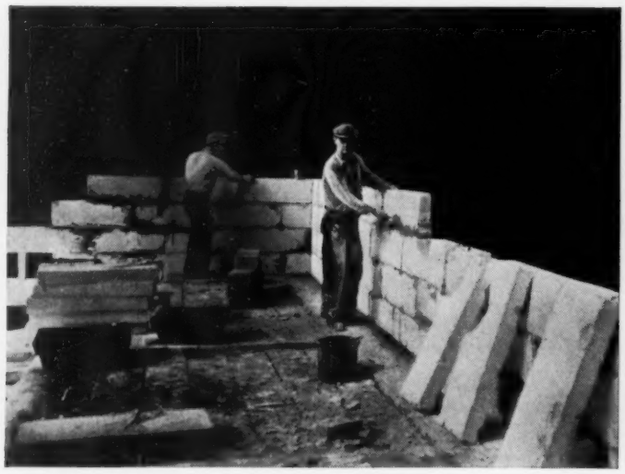
To hold the trolley stationary when raising or lowering a load by this floor-controlled crane, another EC&M Type WB Brake is applied on the trolley-motor shaft. The trolley controller is of the manually-operated type, and for this application the rectifier is a separately mounted, enclosed unit as shown in the illustration to the left of this column.

The propelling drive on this whirler crane is operated by four a-c motors, one on each leg. On each motor is an EC&M Type WB Brake to hold the crane stationary not only when handling loads but to prevent movement by wind when the crane is not in use.

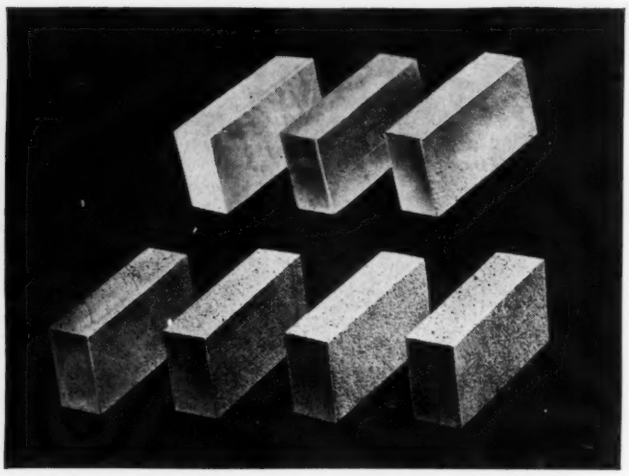
An EC&M *patented* Quadruplex, Magnetic Controller of the Frequency Relay type is used to start, accelerate or stop these 4 motors simultaneously . . . as smoothly as a single motor drive. (Bulletin 930) The rectifier equipment for these 4 brakes is mounted on the rear of this controller — a single rectifier handles all 4 brakes. For control using only 2 motors on the bridge motion, similar control, but of the EC&M *patented* Duplex type for use with 2 motors and 2 brakes, is supplied.

Meet wartime conservation demands with

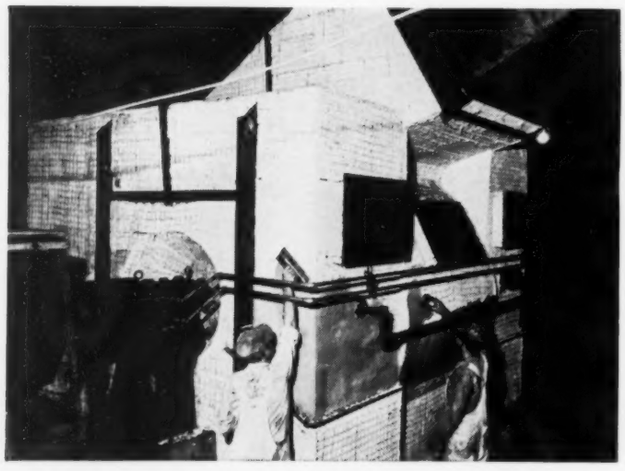
Johns-Manville Insulations



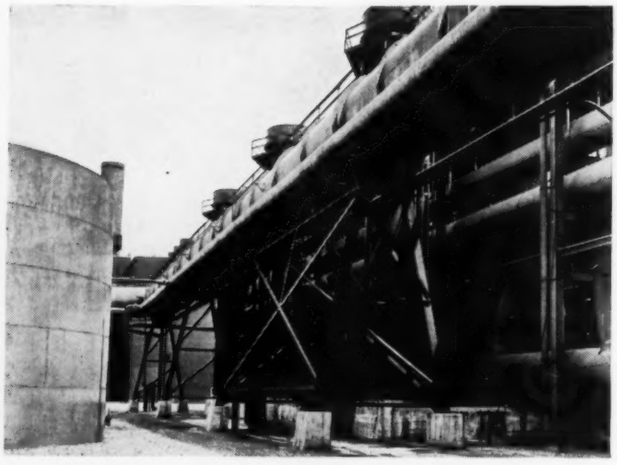
INSULATION FOR TEMPERATURES TO 1900° F. J-M Superex Blocks have long been standard for this service. High heat resistance, low thermal conductivity. Sizes 3" x 18", 6" x 36" and 12" x 36"; from 1" to 4" thick.



FURNACE INSULATION UP TO 2600° F. J-M Insulating Brick and Insulating Fire Brick are available in 7 types, with temperature limits ranging from 1600° F. to 2600° F. All provide light weight, low conductivity.



POWER PLANT INSULATIONS. J-M 85% Magnesia has been for many years the most widely used block and pipe insulation for temperatures to 600° F. and, in combination with Superex, for higher temperatures. Maintains high insulating efficiency. Standard block sizes 3" x 18", 6" x 36" and 12" x 36"; from 1" to 4" thick.



FOR STEAM LINES UP TO 700° F. J-M Asbesto-Sponge Felted Pipe Insulation is recommended where maximum efficiency, high salvage and resistance to abuse are essential. For temperatures over 700°, used in combination with Superex. It is available in 3-ft. lengths, from 1" to 3" thick, for standard pipe sizes.

JOHNS-MANVILLE

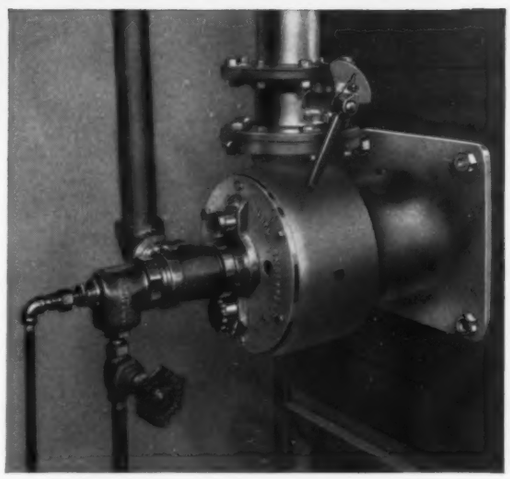
Industrial Insulations

FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE

FOR DETAILS on these materials, and on the complete J-M Insulation line, write for Catalog GI-6A. Johns-Manville, 22 East 40th Street, New York, N. Y.

JOHNS MANVILLE JM PRODUCTS

Install BLOOM LONG FLAME BURNERS



ON FURNACES FOR

BILLET HEATING
ANNEALING
FORGING
INGOT HEATING
HEAT TREATING
NORMALIZING

Are You Facing FUEL SHORTAGES?

With Bloom COMBINATION Burners you can change over INSTANTLY from gas to oil or from oil to gas without delay, without shut-downs, and without changing the heating conditions in your furnace.

Do You Want GREATER PRODUCTION?

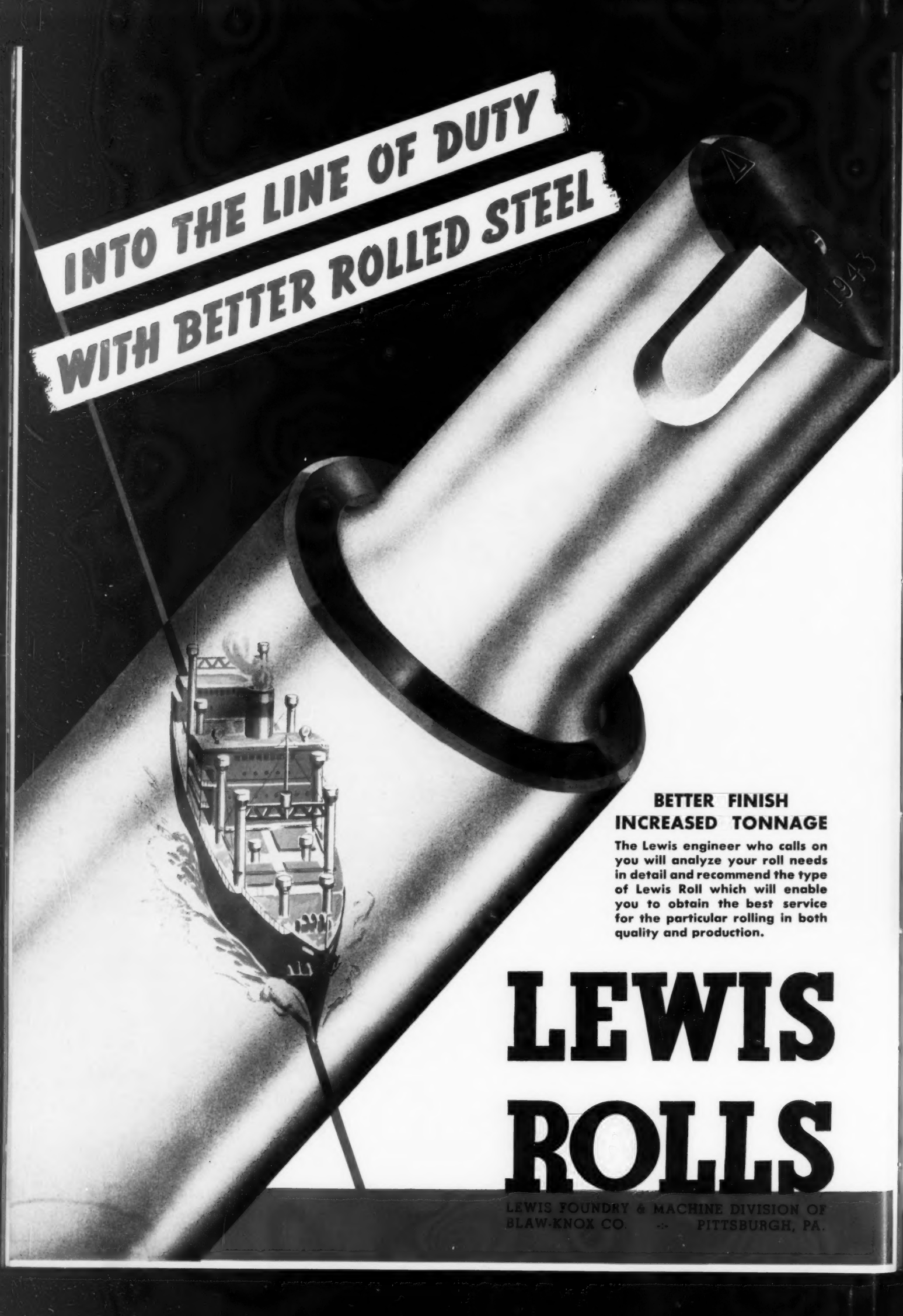
Through the application of modern engineering practice, Bloom can help you get the most out of your present equipment—or guide you in alterations that will increase production.

Is FUEL CONSERVATION *one of your aims?*

Bloom Engineering can help you get the most out of every B.T.U. you put into your furnaces through correctly engineered applications and modern, efficient burners.

BLOOM ENGINEERING CO.
916 BEHAN STREET
PITTSBURGH, PA.

INTO THE LINE OF DUTY WITH BETTER ROLLED STEEL



BETTER FINISH
INCREASED TONNAGE

The Lewis engineer who calls on you will analyze your roll needs in detail and recommend the type of Lewis Roll which will enable you to obtain the best service for the particular rolling in both quality and production.

LEWIS ROLLS

LEWIS FOUNDRY & MACHINE DIVISION OF
BLAW-KNOX CO. -:- PITTSBURGH, PA.

More AND Faster STEEL PRODUCTION

AMCO PIT FURNACES

Steel is the key to war-time production. AMCO Pit Furnaces are doing their part by serving the largest steel producers in the United States and Canada. Operating reports continually show a substantial increase in steel quality, a decrease in chipping costs and a welcome reduction in scale loss, fuel expense and maintenance costs.

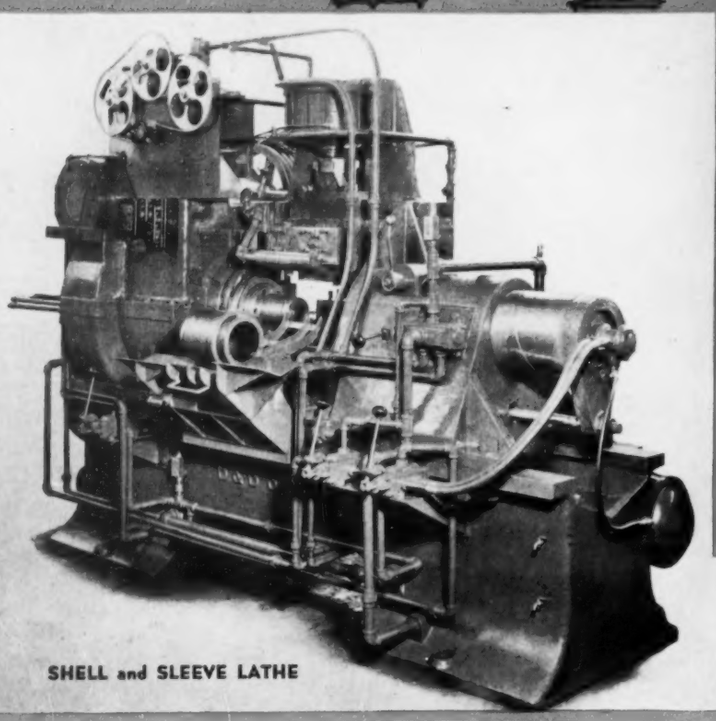
Over 160 in active operation and on order; get the facts.

The AMSLER–MORTON Company

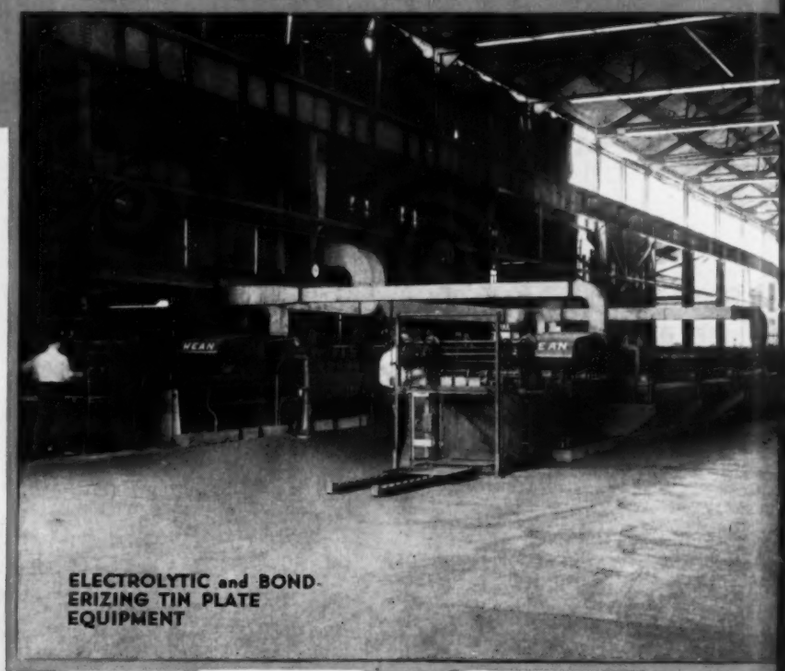
FULTON BUILDING PITTSBURGH, PA.

SPECIALISTS IN SHEET M

The WEAN ENGINEERI COMPANY · · WARREN · · O



SHELL and SLEEVE LATHE



ELECTROLYTIC and BOND-ERIZING TIN PLATE EQUIPMENT

VACUUM CUP SHEET and PLATE LIFTER

Wean equipment is engineered to produce high quality products at high speed.

ASSOCIATED COMPANIES

Lee Wilson Engineering Co.
CLEVELAND, O.

•

The McKay Machine Co
YOUNGSTOWN, O.

Flinn & Dreffein Co.
CHICAGO, ILL.

•

The Wellman Smith Owen Engr. Corp., Ltd.
LONDON, ENGLAND

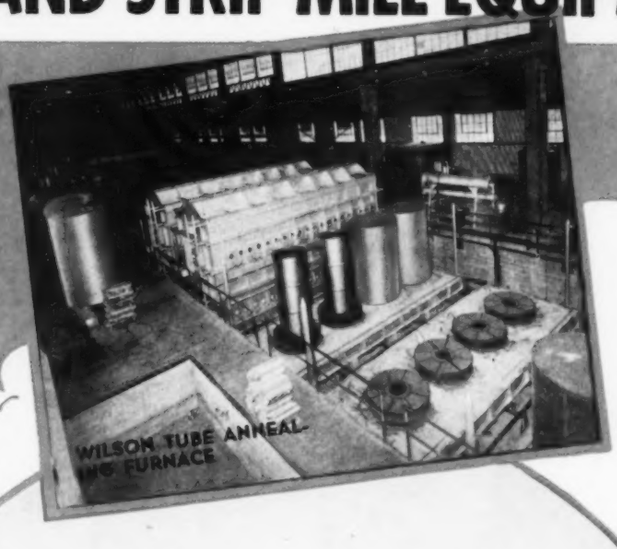
The Hallden Machine Co.
THOMASTON, CONN.

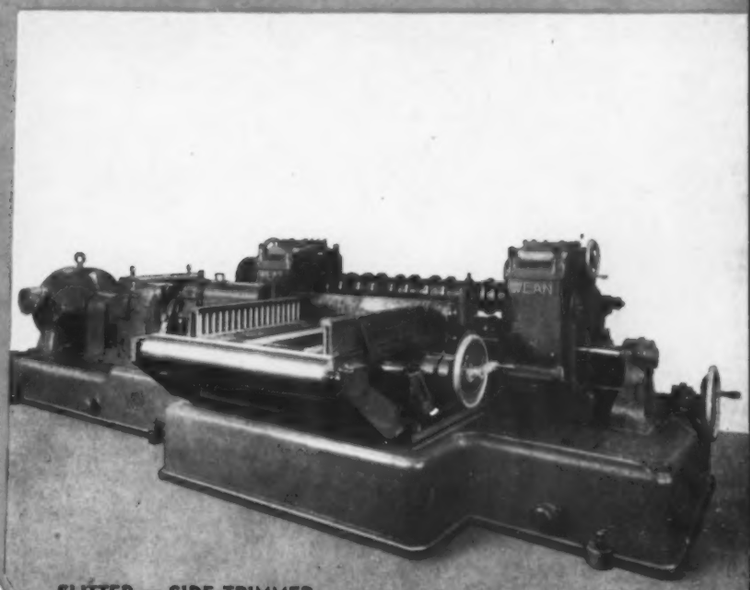
•

The Wean Engineering Co. of Canada, Ltd
HAMILTON, ONT.

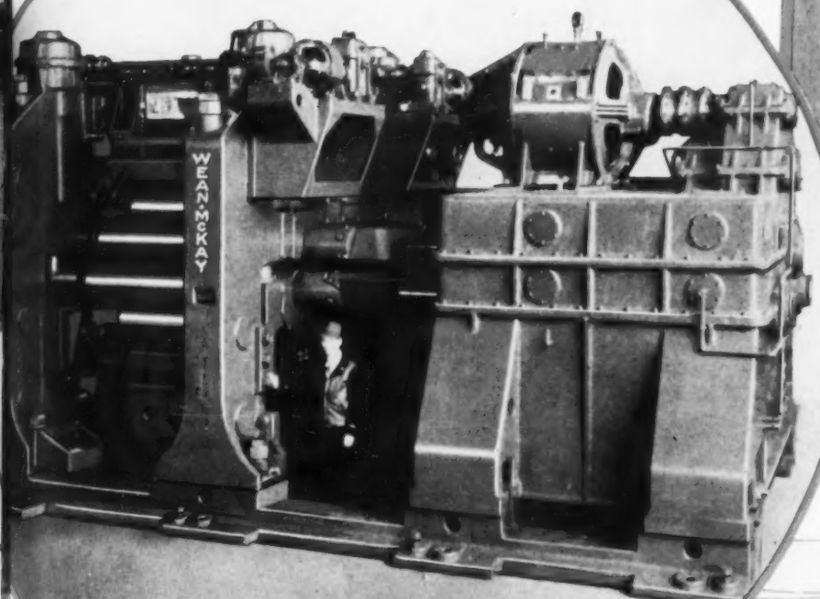
SUBSIDIARY COMPANY THE BRODEN CONSTRUCTION CO., CLEVELAND, O., Mfgrs. of Strip and Wire Mill Machinery

IEEIN AND STRIP MILL EQUIPMENT ★ ★ ★ ★

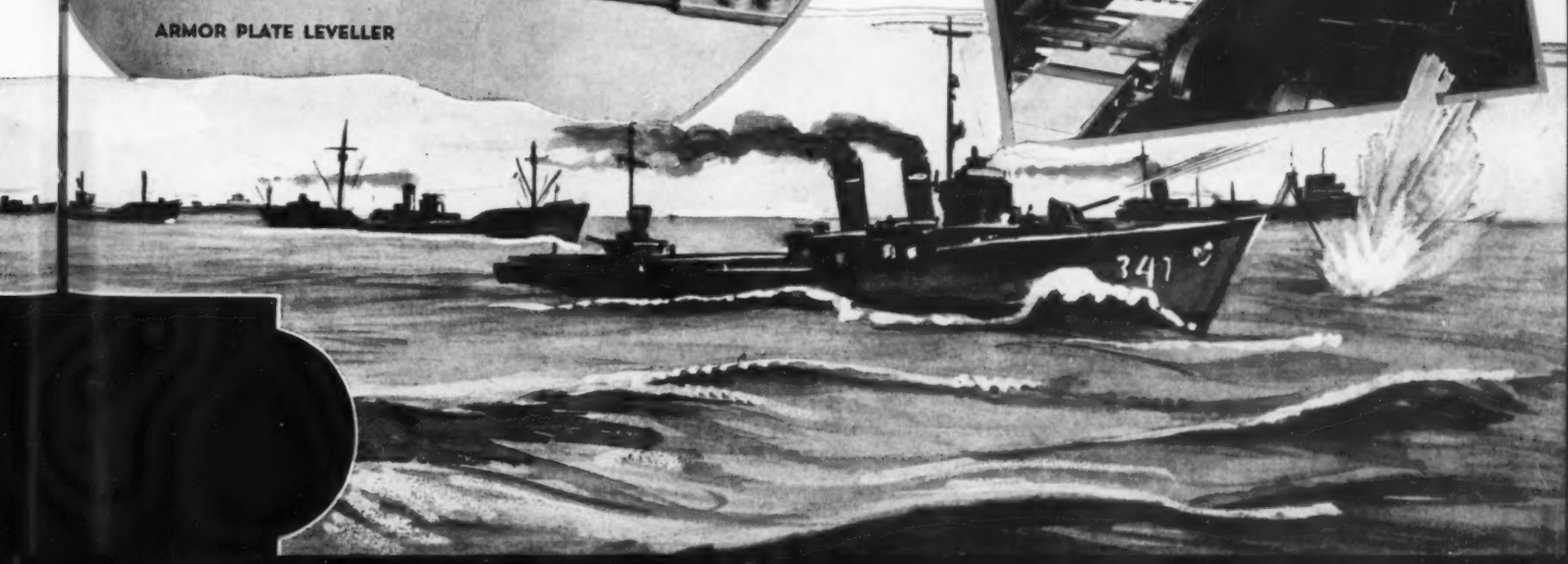


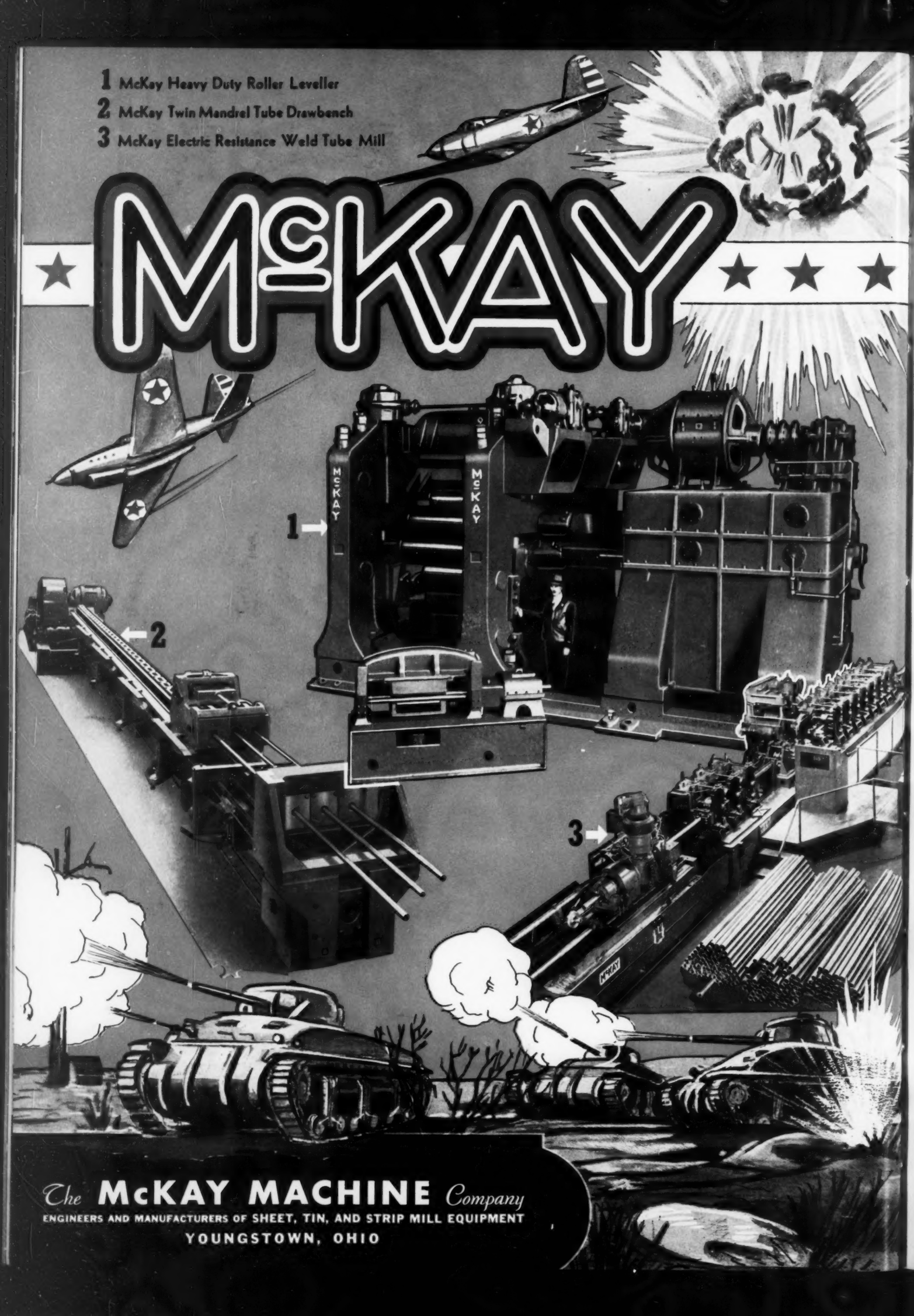


SLITTER or SIDE TRIMMER
[Combination type]



ARMOR PLATE LEVELLER





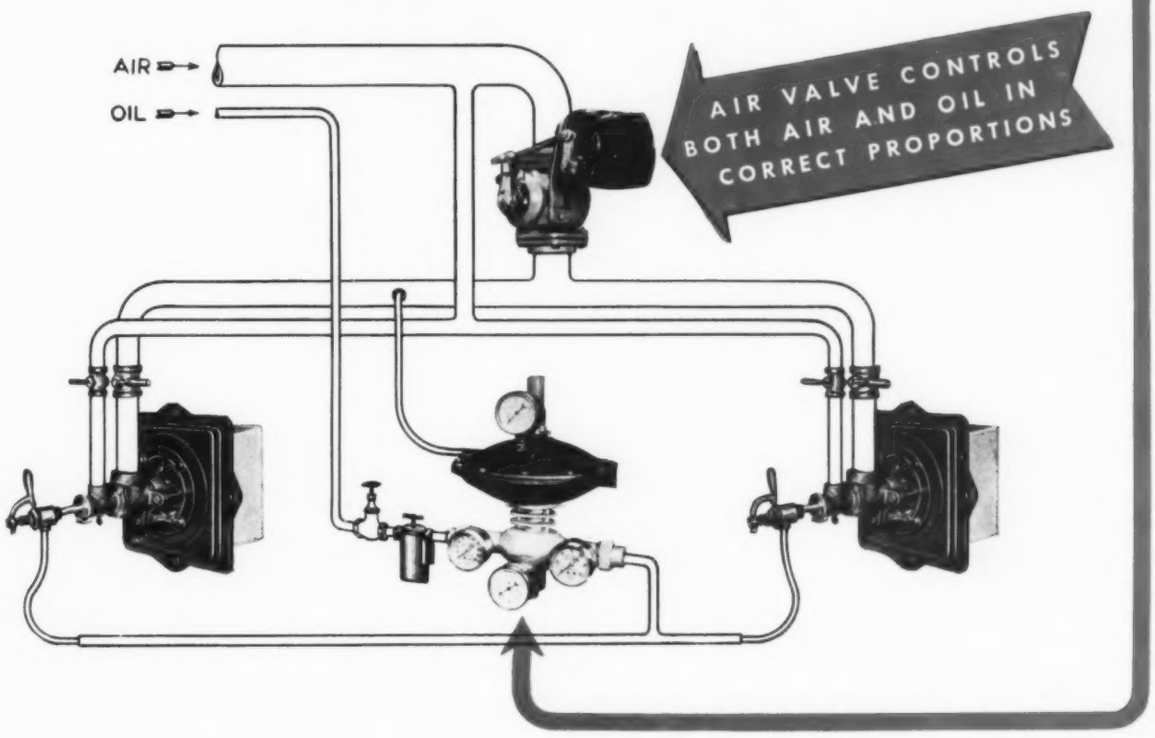
The McKAY MACHINE Company

ENGINEERS AND MANUFACTURERS OF SHEET, TIN, AND STRIP MILL EQUIPMENT

YOUNGSTOWN, OHIO

NORTH AMERICAN

AIR-OIL RATIOTROL



● Oil *pressure* is tied to air *pressure* in the NORTH AMERICAN AIR-OIL RATIOTROL. This fundamentally correct pressure principle of proportioning fuel oil with the air for combustion guarantees greatest combustion efficiency.

One main control valve is installed anywhere in the air line supplying any number of burners. The burners can be mounted on various levels or on opposite sides of the furnace.

The system is easy to install and easy to operate. No complicated adjustments or settings are necessary.

The system will provide reduced maintenance, increased production, more uniform products, better combustion efficiency and reduced "breaking-in" time for new operators. Let us mail you the new Ratiotrol Bulletin No. 13-0.

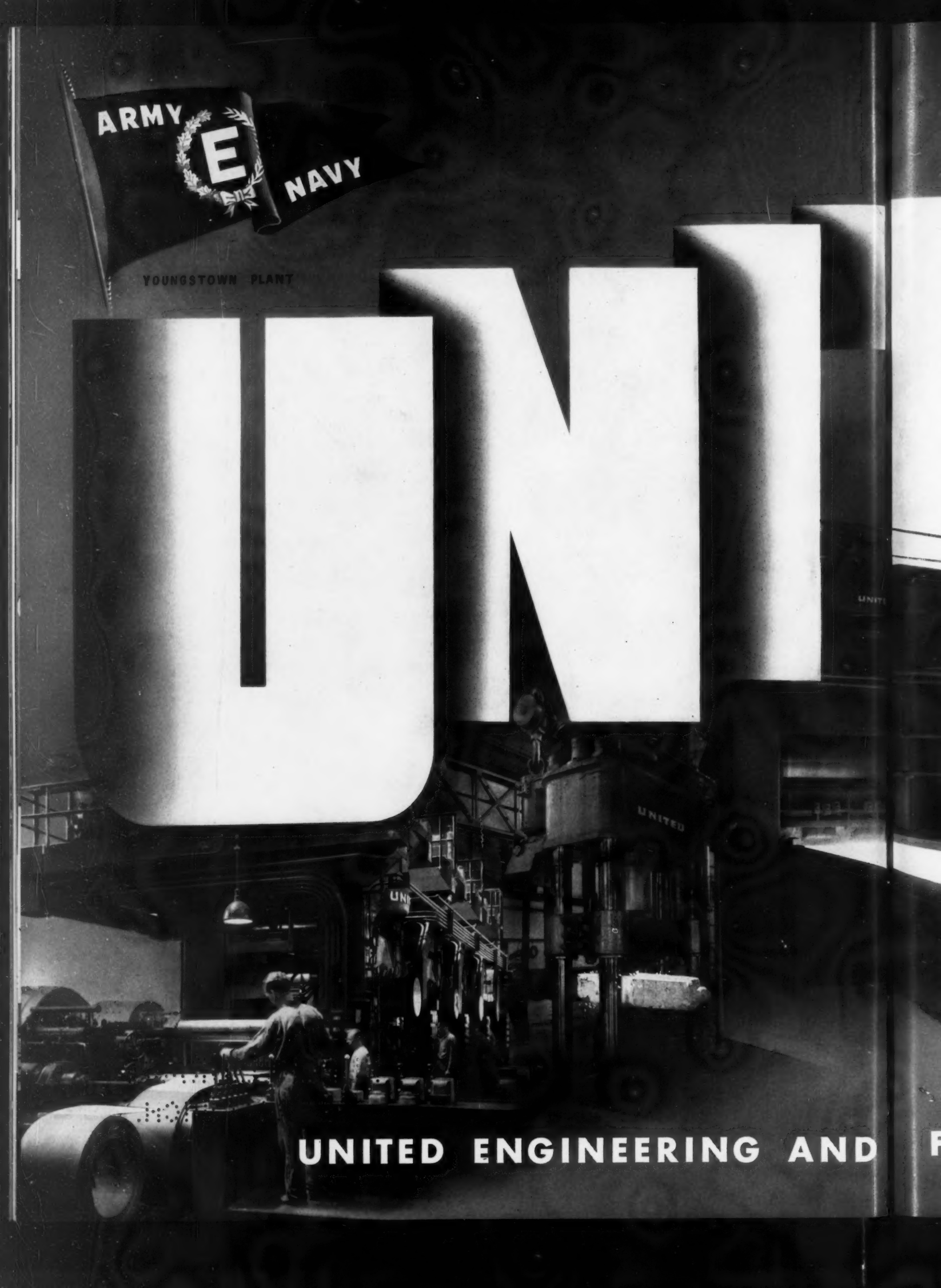
THE NORTH AMERICAN MANUFACTURING COMPANY

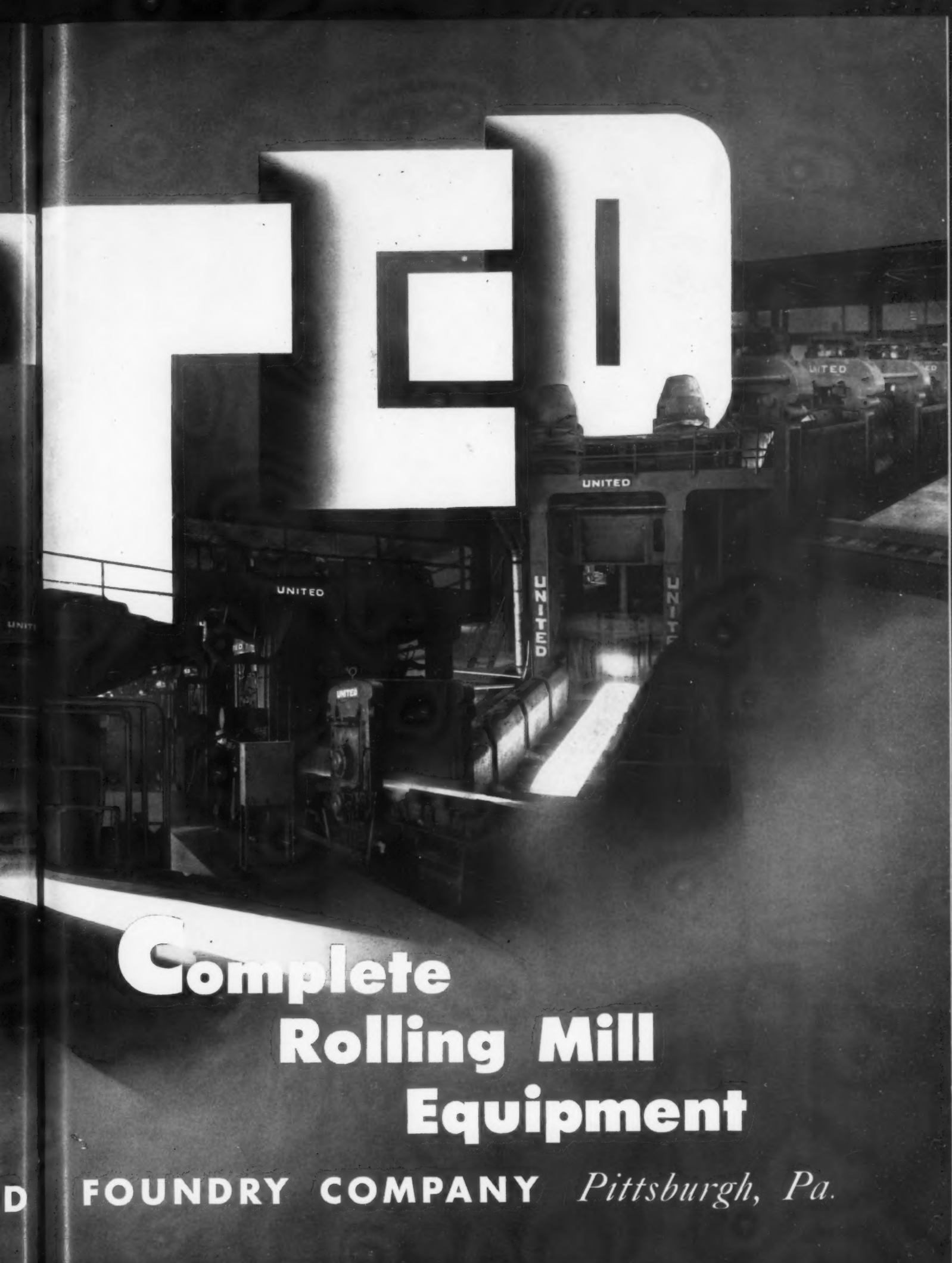
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL

BRANCH OFFICES *with* FIELD ENGINEERS *in* PRINCIPAL CITIES

CLEVELAND, OHIO

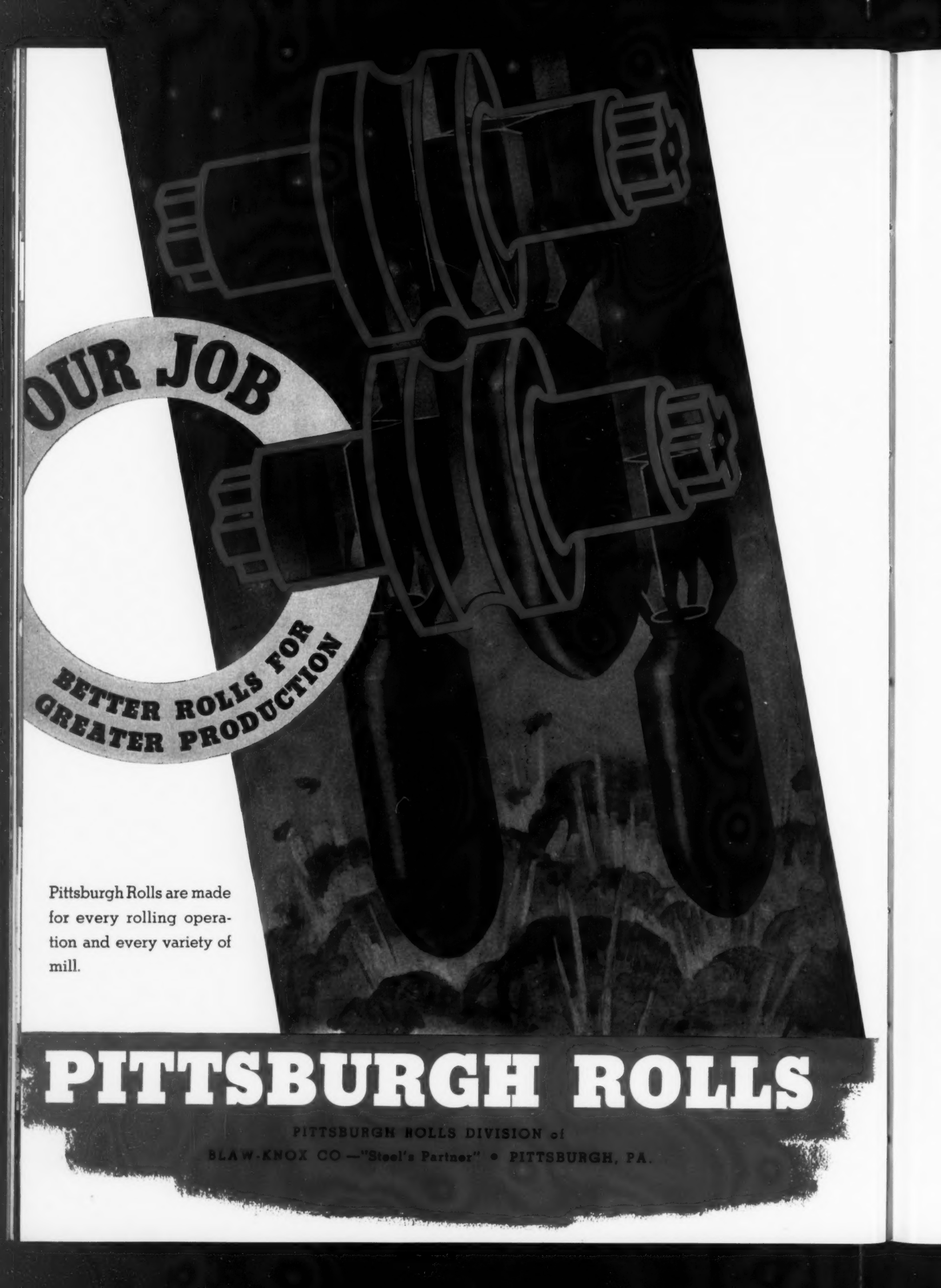
DETROIT MICH.


ARMY
E
NAVY
YOUNGSTOWN PLANT
UNI
UNITED
UNITED ENGINEERING AND



Complete Rolling Mill Equipment

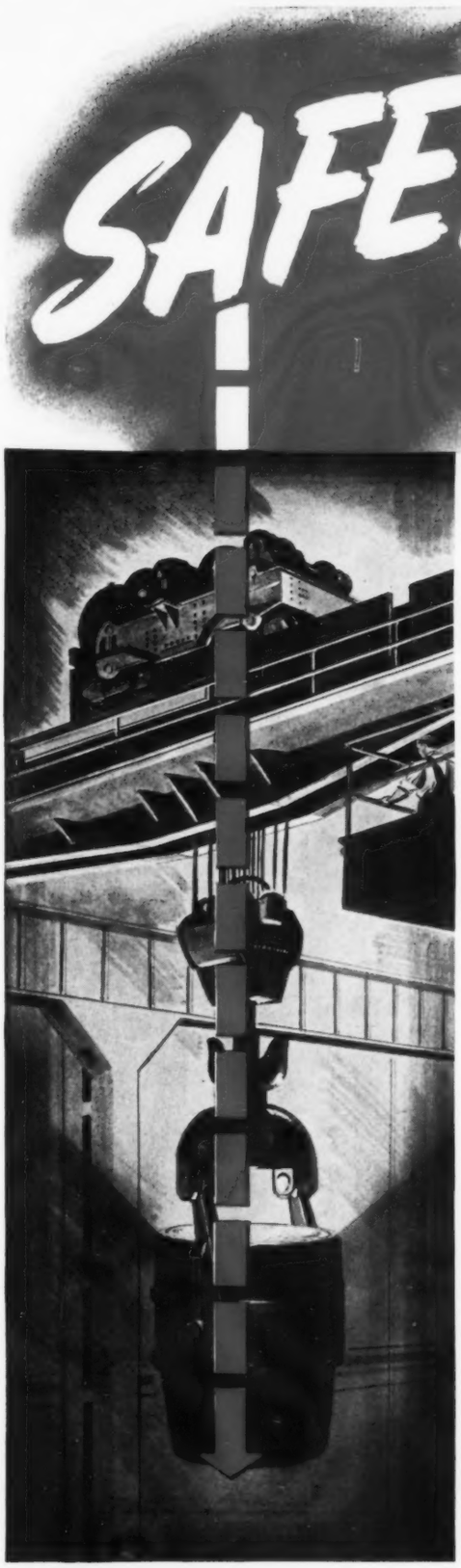
FOUNDRY COMPANY *Pittsburgh, Pa.*



Pittsburgh Rolls are made for every rolling operation and every variety of mill.

PITTSBURGH ROLLS

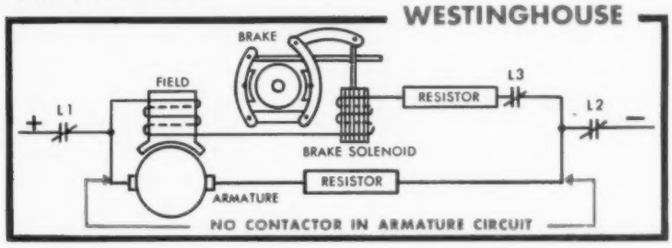
PITTSBURGH ROLLS DIVISION of
BLAW-KNOX CO—"Steel's Partner" • PITTSBURGH, PA.



ALL the way down

with Westinghouse Safety Circuit for D-C Crane Control...

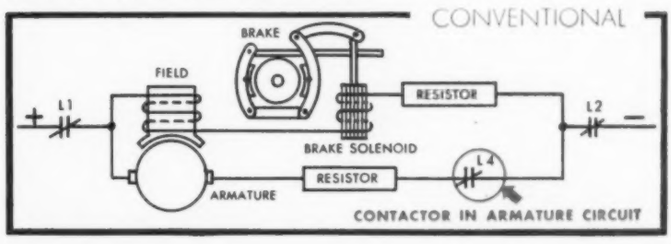
This Westinghouse patented safety circuit makes crane lowering safety completely independent of any possible contactor failure.



Westinghouse achieves this safety by eliminating all contactors in the armature circuit, thus keeping the armature solidly connected across the main line contactors at all times. When the solenoid brake is released, dynamic braking action automatically takes over.

HERE'S HOW:

When lowering, gravity tends to spin the armature. By reversing the field in the Westinghouse safety circuit, the armature stays solidly connected across the line contactors. The motor then acts as a loaded generator and a retarding dynamic braking action takes place. Should the line contactors (L_1, L_2), or field reversing contactor (L_3) fail, the solenoid brake will set. Consequently, lowering safety is completely independent of possible contactor failure.

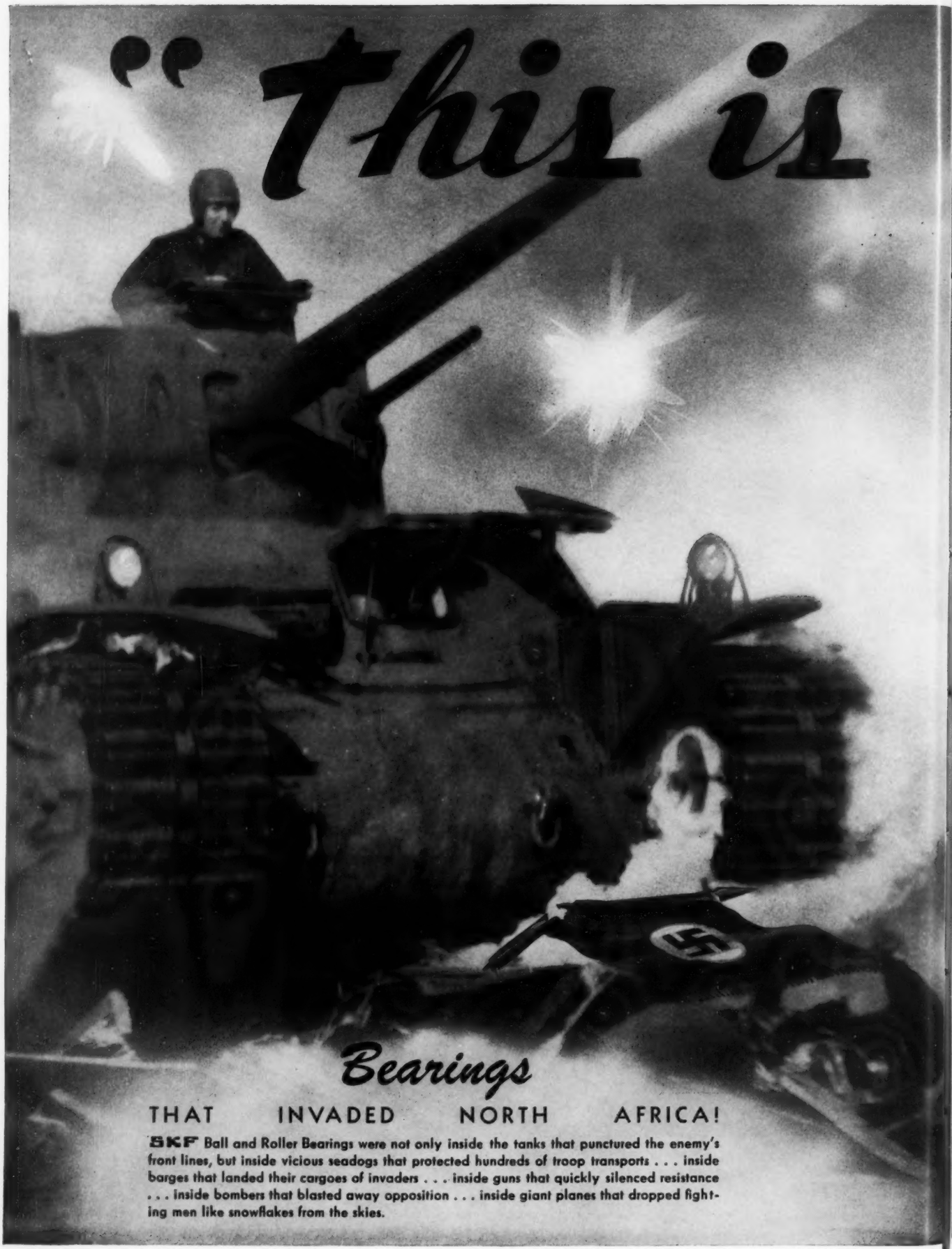


In conventional circuits, the armature is reversed instead of the field, making contactor (L_4) necessary in the armature circuit. Should this contactor fail while the solenoid brake has been released for lowering, the open circuited armature will be free to spin. Since no braking action of any sort will then be available, the load may drop.

Specify Westinghouse "Safety Circuit Control" for your crane—or call your nearest Westinghouse office for complete crane control information. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. J-21260

Westinghouse MOTORS & CONTROL

PLANTS IN 25 CITIES ... OFFICES EVERYWHERE


"This is
Bearings
THAT INVADED NORTH AFRICA!
SKF Ball and Roller Bearings were not only inside the tanks that punctured the enemy's front lines, but inside vicious seadogs that protected hundreds of troop transports . . . inside barges that landed their cargoes of invaders . . . inside guns that quickly silenced resistance . . . inside bombers that blasted away opposition . . . inside giant planes that dropped fighting men like snowflakes from the skies.

it!"

WHAT HAPPENED in North Africa early in November was what the Steel Industry was working for . . . what every crane, car, motor, drive, reeling mill, rolling mill, table and every **SKF** Bearing had been striving for ever since America's freedom was first threatened.

From the very first day the Axis began to march, the Steel Industry had been preparing for North Africa with equipment that with **SKF** Ball and Roller Bearings met the stern challenge of Production.

SKF will see to it that not only the vital moving parts of this equipment, but of the guns, tanks, bombers, battleships and other weapons the Steel Industry produces will continue to "beat the Axis to the draw."

SKF INDUSTRIES, INC., PHILA., PENNA.

5200

SKF

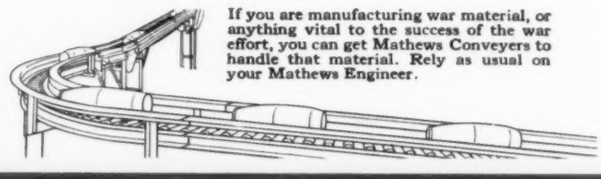
Bearings

TICKETED FOR *Tokio*

TOJO'S Day of Reckoning is coming and Mathews Engineers are working with Plant Engineers to speed that day.

Night and day . . . month after month, Mathews Conveyers are moving an endless procession of bombs, shells, cartridge cases, and vital plane parts, many of them destined to make it warm in Tokio.

If your production depends on precision movement of materials and supplies, a Mathews Time-Coordinated Conveyer System is a sure means of speeding operations all along the line. A Mathews Engineer will gladly consult with you on your problem.



If you are manufacturing war material, or anything vital to the success of the war effort, you can get Mathews Conveyers to handle that material. Rely as usual on your Mathews Engineer.

MATHEWS CONVEYER COMPANY ELLWOOD CITY PENNSYLVANIA

BRENT WILEY, *Editor*

T. J. ESS, *Associate Editor*

JAMES D. KELLY, *Business Manager*

JAMES R. SCOTT, *Production Manager*

Board of Directors

PRESIDENT
FRANK E. FLYNN
District Manager
Republic Steel Corporation
Warren, Ohio

1ST VICE-PRESIDENT, C. L. McGRANAHAN, *Assistant General Superintendent,* Jones and Laughlin Steel Corporation, Pittsburgh Works,, Pittsburgh, Pennsylvania

2ND VICE-PRESIDENT, J. L. MILLER, *Assistant Chief Combustion Engineer,* Republic Steel Corporation, Cleveland, Ohio

TREASURER, J. S. MURRAY, *Chief Electrical Engineer,* Follansbee Steel Corporation, Follansbee, West Virginia

SECRETARY, FREEMAN H. DYKE, *Superintendent, Blooming, Bar and Hot Strip Mills,* Wheeling Steel Corporation, Steubenville, Ohio

PAST PRESIDENTS: THOMAS E. HUGHES, *Superintendent of Maintenance,* Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

WILLIAM A. PERRY, *Superintendent, Electrical and Power Departments,* Inland Steel Company, Indiana Harbor, Indiana

HONORARY DIRECTORS: JAMES FARRINGTON, *Electrical Superintendent,* Wheeling Steel Corporation, Steubenville, Ohio

A. C. CUMMINS, *General Superintendent,* Youngstown District, Carnegie-Illinois Steel Corporation, Youngstown, Ohio

WALTER H. BURR, *Electrical Superintendent,* Lukens Steel Company, Coatesville, Pennsylvania

DIRECTOR-AT-LARGE, J. D. JONES, *Chief Engineer,* Youngstown Sheet and Tube Company, Youngstown, Ohio

DIRECTORS: E. W. TREXLER, *Superintendent, Mechanical Department,* Bethlehem Steel Company, Johnstown, Pennsylvania

H. R. ZIMMERMAN, *Superintendent, Maintenance Department,* Carnegie-Illinois Steel Corporation, Electrical Division, Gary Sheet and Tin Mills, Gary, Indiana

N. C. BYE, *Chief Engineer,* H. Disston and Sons, Inc., Philadelphia, Pennsylvania

A. G. DELANEY, *General Superintendent,* Republic Steel Corporation, Gadsden, Alabama

E. J. WAGAR, *Superintendent, Steam Efficiency and Combustion,* Jones and Laughlin Steel Corporation, Otis Works, Cleveland, Ohio

W. H. COLLISON, *Superintendent,* By-Product Coke Plant, Great Lakes Steel Corporation, Ecorse, Michigan

L. R. MILBURN, *Electrical Engineer,* Great Lakes Steel Corporation, Ecorse, Michigan

A. W. STEED, *Superintendent, Maintenance,* American Rolling Mill Company, Middletown, Ohio

A. S. GLOSSBRENNER, *General Superintendent,* Brier Hill Works, Youngstown Sheet and Tube Company, Youngstown, Ohio

Managing Director
BRENT WILEY
Empire Building
Pittsburgh, Pennsylvania

IRON AND STEEL ENGINEER

JANUARY • 1943
VOL. XX NO. 1

In This Issue

Coal Washing — Its Effect on Coke Oven and Blast Furnace Practice — By W. S. McAleer, District Manager, The McNally Pittsburg Manufacturing Company, Pittsburgh, Pennsylvania 29

Discussion: Coal Washing — Its Effect on Coke Oven and Blast Furnace Practice—Presented by W. T. Brown, G. V. Woody, F. M. Becker, T. C. Campbell and W. S. McAleer 34

Conservation of Critical Materials in Transformer Design — By J. K. Hodnette, Engineering Manager, Westinghouse Electric and Manufacturing Company, Sharon, Pennsylvania 36

Discussion: Conservation of Critical Materials in Transformer Design — Presented by K. B. McEachron, H. H. Wagner, J. S. Murray and J. K. Hodnette 41

Sheet and Tube Now Operating New Modern Sintering Plant 46

Republic Steel Operates New Blast Furnace — By John Stouffer, Chief Engineer, and Malcolm Morgan, Superintendent of Coke Plant and Blast Furnaces, Republic Steel Corporation, Youngstown, Ohio 49

Palm Oil — Its Utilization in the Steel Industry — By R. P. Dunmire, Vice President, Buckeye Laboratories, Inc., Cleveland, Ohio 55

Synthetic Scrap by Direct Reduction — By E. S. Harman, Vice President, Loftus Engineering Corporation, Pittsburgh, Pennsylvania 66

Developments in the Iron and Steel Industry During 1942 — By W. H. Burr, Chairman, A. I. S. E. Developments Committee, and Electrical Superintendent, Lukens Steel Company, Coatesville, Pennsylvania 76

Latest Design and Equipment for the Industry 112

Items of Interest 122

Index to Advertisers 145

Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS

Entered as second-class matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expression of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility. Copyright, 1942, The Association of Iron and Steel Engineers

Single Copy Foreign Prepaid $2.00 Single Copy $1.50
Subscription price in U. S. & Canada ..... $ 7.50 per year
Subscription price in foreign countries ..... $10.00 per year

PLASTIC BINDING U. S. PATENT NO. 1978281 LICENSE NO. 120

F. E. FLYNN

President

1943

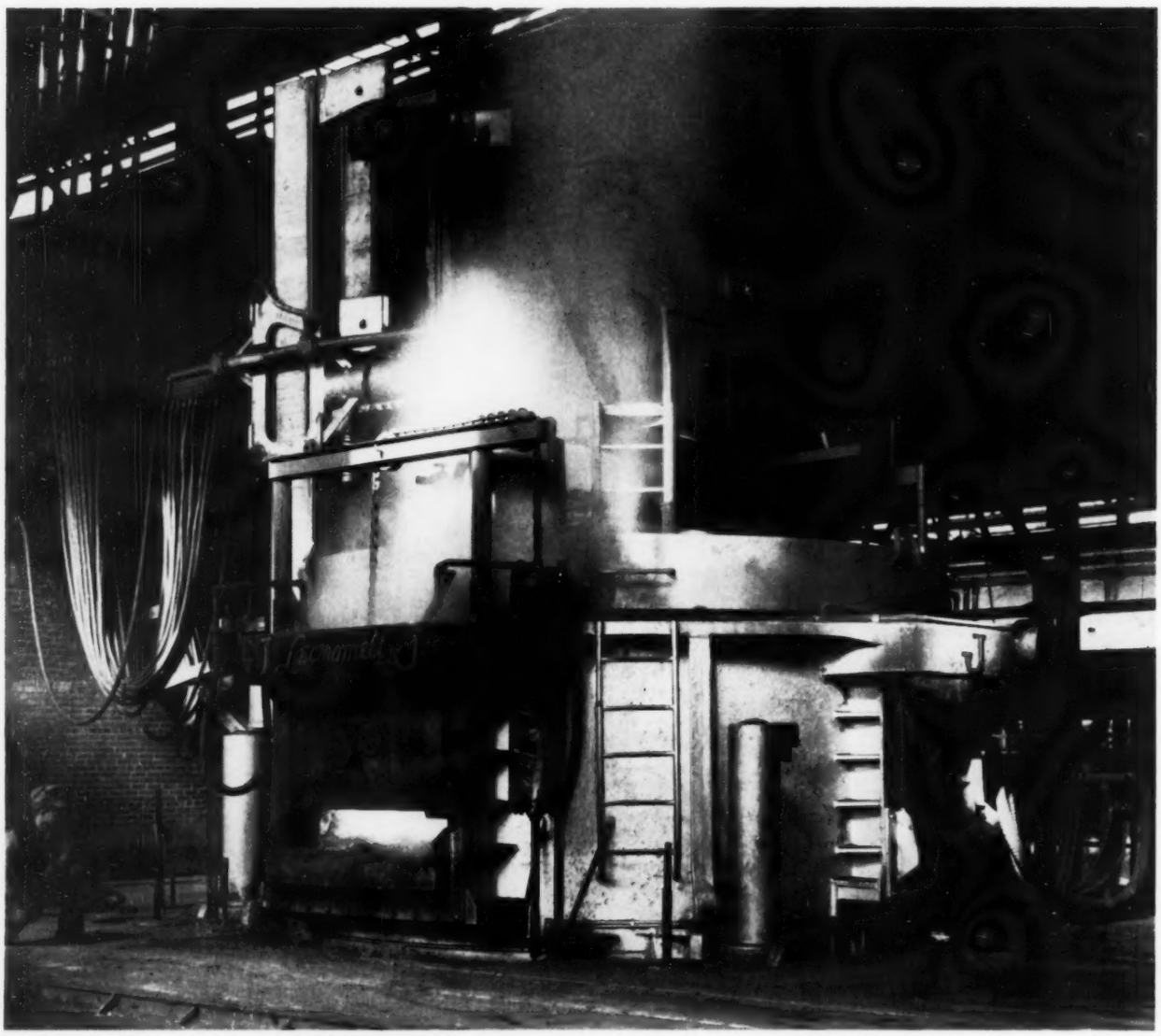
ASSOCIATION OF IRON AND STEEL ENGINEERS

The President's Message

As I write this message I am reminded of the very high honor that has been conferred upon me. I am thinking of the long and honorable past of this Association and the tremendous part it has played in the development of the iron and steel industry. I am also thinking of the traditions that have surrounded this Association from its inception. I cannot forget the men who have been presidents of this Association, or the many fine things they have contributed.

With all of these things before me, I again say that I am deeply conscious of the very high honor which has been conferred upon me. It is my hope to be able to carry on the work of this Association, with the help of its members, as it should be during these trying times. I pledge that I will devote my energy and experience to the affairs of this Association in such a way that when the time comes to pass the gavel to my successor, we all will feel that the Association has continued to serve our industry in the manner that it should.

Large tonnage *and Highest Quality*



★ Lectromelt furnaces are producing highest quality steels in large tonnages. Illustrated is one of the 75-ton Lectromelt furnaces on alloy steel production in a large Eastern plant. Lectromelts are built to give long service. Operation is economical and efficient. They are available in standard size from 100 ton down to 25 pound capacities, in both top charge and door charge types.

MOORE RAPID
Lectromelt
FURNACES

PITTSBURGH LECTROMELT FURNACE CORP.
PITTSBURGH, PENNA.

The Furnace of Today and Tomorrow

Coal Washing – ITS EFFECT ON COKE OVEN AND BLAST FURNACE PRACTICE

. . . . . coal washing reduces the ash and sulphur content of the coke, giving increased blast furnace production from existing furnaces . . . . .

by W. S. McALEER, DISTRICT MANAGER

The McNally Pittsburg Mfg. Co.

Pittsburgh, Pennsylvania

▲ BY COAL washing we mean the separation and removal of the heavier specific gravity fractions such as clay, shale, pyrite, etc., from the lighter fractions or good coal substance of a coal seam.

This separation is accomplished commercially in many ways by a wide variety of specially designed apparatus, most of which use controlled water currents, mixtures of heavy density substances with water, or air to simulate a fluid having a gravity somewhere near the gravity at which the separation is to be made.

Some of this equipment is designed to cope with certain specific conditions and a modern coal preparation or washing plant generally consists of a wise selection of apparatus, combined on the basis of experience to form a well integrated process of preparation which will give the most uniform product in the most economical manner for the minimum practical investment.

When we consider the wide variation in analysis of mined coal, both chemically and from the standpoint of specific gravity, that occurs from seam to seam, likewise from mine to mine in the same seam and to a lesser extent from place to place in the same mine; we realize that the proper selection of a coal washing equipment or a coal washing process can only be made after a thorough study of the chemical and specific gravity analyses of representative samples. Due consideration must also be given to the ultimate use of this coal.

All of these factors introduce variables into the problem which will change radically between different parts of our country. The picture is further complicated when looked at from the viewpoint of the blast furnace operator, because here we add more variables such as quality of ore desired, analysis of iron, etc.

It is not possible to give due consideration to these many different conditions, so we will confine our present discussion to the treatment and use of Pittsburgh seam coal.

The Pittsburgh seam of coal is found in southwestern Pennsylvania, northern West Virginia and eastern Ohio, an area of about 5700 square miles. However the portion of this coal which is suitable for metallurgical use is found almost entirely in Pennsylvania and has an area of about 2100 square miles. This is the most valuable mineral deposit ever worked and is the source of about one-third of the total coal coked annually in the United States.

By a peculiar coincidence, the early workings in this seam, many of which were within the present limits of the city of Pittsburgh, produced the best coal in regard to ash and sulphur analyses and coking quality.

A large portion of this extremely good coal is now depleted and each year we are forced to mine a larger amount of poorer quality coal, i.e., of higher ash and sulphur content. Concurrent with this general trend, the steel industry is demanding coal of lower and more uniform ash and sulphur content. The main problem of the mining industry and of the builders of coal preparation plants is to meet or economically balance these divergent trends.

This problem is further complicated by present economic conditions. Due to high wage rates and a growing labor shortage, mining men are being forced to

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pennsylvania September 22-24, 1942

Figure 1 — Modern metallurgical coal washing plant.

mechanize large sections of their mines and in many cases entire mines are now 100 per cent mechanized. Mechanization almost invariably increases the ash and sulphur content of the mined coal and the quality is less uniform.

In order to better understand why mined coal contains a variable amount of objectionable material and lacks uniformity in size and quality, let us consider in a general way, the makeup of the Pittsburgh seam.

This seam itself varies in total thickness from about 60 in. in some districts to about 108 in. in other districts, while in certain localized areas it exceeds 108 in. The coal is laid down on a fireclay bottom, which if lifted with the coal increases the ash content. This material can be removed by a preparation plant, but it readily slacks in water, fouls the water system in the washing plant and part of it will eventually raise the ash content of the very fine coal.

Above this fireclay is a high sulphur, high ash coal of variable thickness whose quality cannot be improved appreciably by washing. The thickness of this coal varies from about 6 to 10 in. and there is a definite split between it and the fireclay.

Next above the bottom coal and with no definite line of demarcation or separation, is the bottom bench. This coal varies in thickness from about 20 to 32 in., is fairly uniform in quality and can be further improved by proper preparation.

Above the bottom bench are two thin slate bands with a thin layer of coal between, having a total thickness of about 6 in. and generally referred to as "bearing in bands." These bands provide a definite separation between the bottom bench and the coal above. These bands are high in ash and if included in the mined coal will generally add as much to the ash content of the output as the ash of both the top and bottom bench coal. Their effect on sulphur is negligible and the slate portion of the band material can be rejected in a washing plant and the coal between the bands can be recovered.

Next above the bearing in bands, is the top bench of coal of variable thickness and as a rule this portion of the seam increases or decreases in thickness over wider limits than any other part of the seam. It is rarely less than about 22 in. thick and may be found more than 50 in. thick. Generally this part of the seam contains the best quality coal. In some localities the upper 5 to 10 in. of this bench is relatively high in phosphorous and this portion of the bench shows more variation in quality than any other part of the seam. Coal from this bench can be improved in quality by proper preparation.

Above the top bench, there are many variations in the seam throughout the district, but in general we find drawslate of variable thickness, which is a high ash material that can be removed in the preparation plant.

Above the drawslate, in some sections there is found a layer of "wild coal" or "rooster coal," high in ash and sulphur and practically impossible to improve to metallurgical grade coal by washing; although in a plant of proper design this coal can be largely recovered as a steam coal product.

With such a variation in amounts of diverse materials to contend with, it is easy to see why there is often great variability in the quality of coal delivered to the coke plant and in the analysis and structure of coke received by the blast furnace, unless great care is taken in mining, blending and washing prior to use.

TABLE I
PERCENTAGE OF MATERIAL SINKING AT 1.60 SP. GR.

Size	Mine A		Mine B	
	Hand	Mechanical	Hand	Mechanical
Over 4 in.	1.0	20.0	1.0	15.0
4 in. x 2 in.	3.0	10.0	3.0	8.5
2 in. x 1 1/8 in.	5.0	11.0	5.0	8.0
1 1/8 in. x 3/8 in.	7.0	11.0	8.5	8.0
3/8 in. x 0 in.	7.0	11.0	6.0	8.0

Until comparatively a few years ago, when all coal was mined and loaded by hand, a great deal of supervision and care was exercised underground to see that only the good coal was loaded out. The bottom coal was left in place, the bearing in bands were carefully rejected underground and generally the top coal, drawslate and wild coal were left in place. If any or all of these portions had to be removed, the miners were extremely careful to see that they were taken out in a manner that prevented their contamination of good coal.

Furthermore, when hand mining, there were a great number of working faces within a given mine, with a relatively low production per face. This in itself tended to equalize the variation in ash and sulphur of the different faces and resulted in a mine output fairly uniform in quality.

With present methods of mechanical mining the same degree of care and selection can no longer be maintained underground.

Because of the large investment in mechanical equipment and the relatively large output of each mechanized unit, there will be far fewer working faces in any mine for a given daily output. This concentration of production alone accounts for non-uniformity in quality. The use of this equipment also causes some of the bottom coal to be cut and loaded and at times some of the fireclay bottom is loaded out, because the bottom is not level, but has a rolling or wavy character. Often the drawslate is weak and difficult to hold in place and some of it may be loaded out with the coal. In localities where the seam is thinner it becomes necessary to remove the top coal, the drawslate, the wild coal or all three of these portions of the seam in order to obtain enough height for movement of equipment. As a rule this must be done where the total seam thickness is less than 80 in.

Although the mining people use every precaution to prevent these undesirable materials from being loaded out, nevertheless from time to time more or less of this material finds its way into the mine output and the result is a higher ash and sulphur content in the coal and above all a greater variability in quality.

Another trend or development adding to this problem is the fact that there is a tendency to shoot the coal harder, decreasing the amount of lump coal and increasing the amount of fine coal. This is done to facilitate mechanical loading and it generally results in increasing the amount of impurities in the increased percentage of fine coal. Impurities of this type are the most difficult to remove in the preparation plant.

Two typical illustrations of the increase in impurities when going from hand mining to mechanical mining are shown in Table I of percentage of material sinking at 1.60 specific gravity. This material is all high ash and sulphur material and the data is from mines in which great care is exercised and whose practice is considered extremely good.

The above data was obtained about two years ago when the mines were not being pushed for maximum output. Present day operation would probably show an average of possibly 2 per cent further increase in refuse materials.

The purpose of a coal washing plant or preparation process, then, is to mechanically remove this extraneous material and to produce a metallurgical grade coal of uniform quality with the lowest ash and sulphur analyses consistent with economical recovery.

In some sections of the Pittsburgh district this can be done by making a two product separation, i.e., good coal and refuse; in other parts of the district it is necessary to make a three product separation, i.e., good coal, middlings or boiler coil and refuse. Even with plants making only two products, it is often advisable and always economical to isolate the middle gravity fraction, crush this fraction and return it to the feed for rewashing, or in some cases rewash it in a separate unit. This is done because this middle gravity fraction is usually made up of laminated strata of good coal with boney binders or pyrite streaks. This bone and pyrite is set free by crushing, is removed by rewashing and the coal values are recovered as metallurgical grade coal.

Some of this middle gravity material or laminated material is found in the two main breasts due to inclusions of pyrite streaks or lenses, some is in the bearing in bands with their included coal and some may be found in the bottom and top coal. When a plant is designed for a three product separation, less care is required in mining and some of the bottom and top coal can be loaded out and recovered in the washing plant as a steam coal. This lowers mining costs and increases mine recovery.

The following example will show how recovery and analysis will vary by following this plan. At a certain mine if the coal is washed on the basis of a two product separation, for maximum recovery we will obtain a product with 5.93 per cent ash and 1.14 per cent sulphur and have 94.96 per cent recovery. If we make about 20 tons per hour of steam coal or 3.8 per cent of the washing plant feed, we will have a metallurgical coal with 5.71 ash and 1.11 sulphur and 91.16 per cent of the feed

Figure 2 — Coarse coal washing launders.

will be of this quality. The total recovery as metallurgical coal and steam coal will be 94.96 per cent.

If we take this same coal and wash at a lower gravity making a two product separation to obtain 1.11 per cent sulphur, the ash will be 5.65 per cent and total recovery will be 93.30 per cent. This shows an added loss of 1.6 per cent or 8 tons per hour, when washing for lowest sulphur results.

A modern coal preparation plant in this district should have a blending bin of ample capacity so that the feed to the coal washer can be equalized and its quality made more uniform. The washing equipment will give better results with less supervision and the equalization of quality will be reflected in the coke ovens and blast furnace.

The effect of blending and washing in reducing variability in quality is shown by the following data on ash analysis which was carefully obtained while producing 2,410 cars of cleaned coal, about 12,000 tons.

	Raw coal		Cleaned coal
	Before bins	After bins	
Average ash, per cent	10.40	10.20	6.0
Maximum ash, per cent	24.30	14.0	8.0
Minimum ash, per cent	6.70	7.80	5.0
Probable error	1.53	0.86	0.14

In some mines, especially those covering a large area, a certain amount of blending or equalization is accomplished by segregating trips of mines cars from the high ash and sulphur, low ash and sulphur and medium ash and sulphur working places. These cars are then dumped according to a predetermined plan which will tend to equalize the ash and sulphur in the run of mine output.

A further aid toward uniformity of product comes in layer loading the barges or railroad cars for transit between the mine, the preparation plant, the coke plant and blast furnace. In addition to layer loading, the use of loading booms that can be lowered down into the barge or car will reduce segregation which is another source of non-uniformity.

When washing it is comparatively easy to remove coarse refuse materials, i.e., say in the plus 5/16 or 3/8 in. size; but for good quality metallurgical coal it is also very necessary to obtain a thorough and efficient removal of the extraneous material in the minus 3/8 in. size, especially in the 3/8 x 20 mesh or 28 mesh portion. This is readily apparent if we consider that a piece of refuse in the form of a 1 in. cube represents only one piece. If this same piece is broken into cubes 1/8 in. on a side, there will be 512 pieces to remove, each one of which is much more difficult to remove than the 1 in. cube. Furthermore, each of these small pieces is a possible cause of non-uniformity of product and is a potential source of coke fracture. Therefore the removal of this fine refuse quickly improves coke structure. This is borne out by a test in which almost 100,000 tons of washed coal were coked. When washing all the coal down to 0, the fuel index of the coke was 85. For about one week the minus 3/8 coal was by-passed around the plant raw, remixed with the washed plus 3/8 in. coal and then coked. The fuel index of the coke dropped to 70.

As a general statement, it is of greater importance to thoroughly wash the fine coal to obtain maximum sulphur reduction. Some of the pyritic sulphur is found as small flakes, some breaks into small cubes and in general the fine coal will show a better sulphur reduction by washing than can be obtained in the coarse coal.

Irrespective of the size of material, an efficient washing plant should be capable of maximum reduction of sulphur even in the finest sizes. Although ash materials finer than 20 or 28 mesh in the washed coal may not be detrimental to coke structure, sulphur in any size is a handicap in blast furnace operation. For this reason great care should be given to plant design to secure maximum sulphur reduction.

Inasmuch as sulphur is perhaps the most critical material occurring in coal so far as the coke plant and blast furnace operations are concerned, it might be well to consider the forms in which it occurs in coal and the degree to which it may be removed.

Sulphur is found in three forms, pyritic, organic and as sulphate.

In the Pittsburgh seam pyritic sulphur is about 40 to 45 per cent of the total sulphur and may occur in localized streaks, lenses, balls or may be small flakes or cubes well distributed throughout the coal seam. A good coal washing plant should remove about 50 per cent of this material and this is about the only place where we can obtain any appreciable reduction in the total sulphur.

Organic sulphur which accounts for about 55 to 60 per cent of the total sulphur exists as organic com-

TABLE II

FURNACE COKE PRODUCED FROM

	Unwashed coals			Washed coals		
	Maximum	Minimum	Range	Maximum	Minimum	Range
Ash, per cent	14.07	10.86	3.21	11.04	9.92	1.12
Sulphur, per cent	1.13	.82	.31	.95	.75	.20

pounds rather uniformly distributed throughout the coal substances and at the present time there is no known method of coal preparation which will reduce this form of sulphur.

When sulphate form of sulphur is found it is usually easy to remove and it rarely accounts for as much as 2 per cent of the total sulphur.

From this it can be readily seen that it is not possible to predict the sulphur in washed coal unless we know not only the total sulphur in the raw coal, but also the form in which this sulphur is present. Fortunately the organic sulphur in Pittsburgh coal is comparatively uniform and variations in total sulphur content generally indicate an increased or decreased amount of pyritic sulphur. For this reason we are usually able to obtain a greater percentage reduction of total sulphur as the percentage of total sulphur in the raw coal increases and conversely why coals inherently low in total sulphur show less improvement in washing.

As a rule the reduction of ash and sulphur by washing are related and it is not economically possible to concentrate on sulphur reduction by itself.

Washed coal produced by a well designed plant will give the coke plant operator a uniform material of as low ash and sulphur analysis as can be obtained from a particular raw coal without excessive bank loss.

The greatest benefit obtained in the by-product coke plant is uniformity of coke analysis. A fifteen day test at the Clairton plant of the Carnegie Illinois Steel Corporation on coke made from the same coal washed and unwashed illustrates this greater uniformity (Table II).

The next benefit is probably the improvement in coke structure and the greater yield of blast furnace coke. H. W. Seyler shows that the yield of blast furnace coke plus 1¼ in. size was increased from 60 per cent when using raw coal to 62 per cent when using washed coal. R. W. Campbell states that there was an increase of 1 per cent in the blast furnace coke, when using washed coal and that while the percentage of coke retained on a 4 in. screen was slightly less for washed coal coke, the total retained on a 2 in. screen increased from 56.5 per cent (unwashed coal coke) to 69.2 per cent (washed coal coke).

According to Seyler the fuel index of the coke was raised from 80 for unwashed coal coke to 91 for washed coal coke. Campbell's work showed that on his coals, washing raised the physical fuel value from 26.17 to 36.93.

Because of sulphur reduction in the washed coal there is a decrease in the amount of hydrogen sulphide produced in coking and this reduces the cost of gas purification. Seyler shows this reduction to be about 20 per cent and his comparisons are on unwashed coal with 8.62 ash and 1.11 per cent sulphur and washed coal with 7.33 per cent and .99 sulphur. As these analyses spread on other coals there is ample reason to believe the savings and benefits will be greater.

There is probably another source of benefit to the by-product plant operator and that is an increase in the yield of by-products due to the fact that by reducing the ash and sulphur content in the washed coal, the percentage of volatile matter automatically increases. Campbell has shown that when washing a coal containing 9.72 per cent ash and 1.20 per cent sulphur to one containing 6.44 per cent ash and 1.06 per cent sulphur,

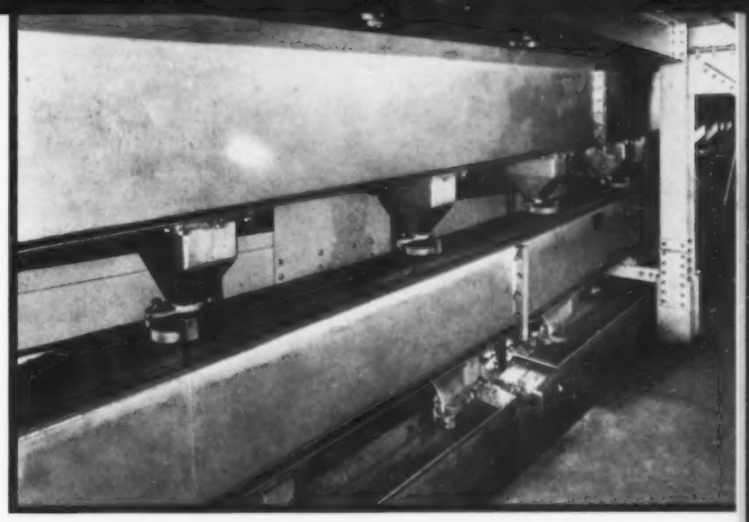


Figure 3 — Fine coal washing launders.

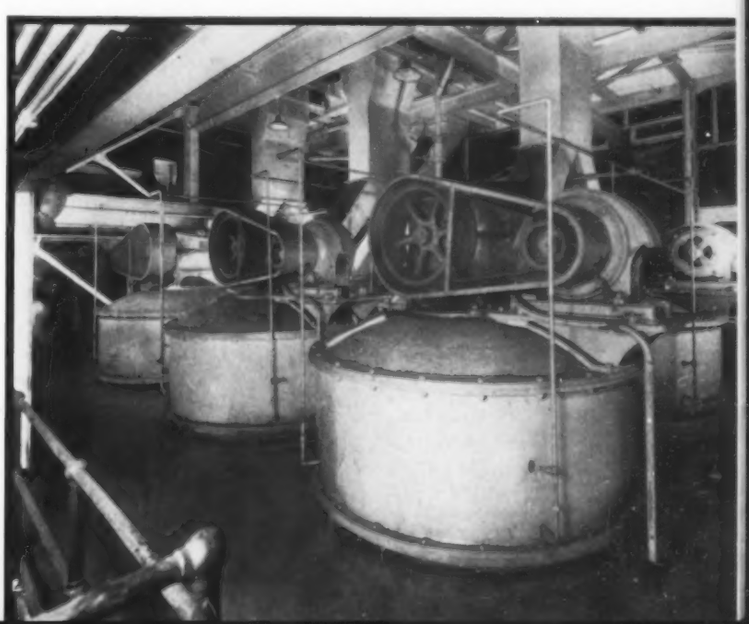
the percentage of volatile matter increased from 34.39 to 36.14 per cent. It is not easy to determine whether or not any practical advantage can be taken of this increase in volatile matter because several other factors tend to nullify this gain. It would be necessary to run a full scale by-product test to determine this point, which to the writer's knowledge has not as yet been done. The factors which obscure or nullify this apparent source of benefit are the added moisture in the coal as charged and the lowering of bulk density that accompanies an increased moisture content.

The benefits obtained by coal washing probably show to the best advantage and profit in blast furnace operation. This is borne out by full scale blast furnace tests which have been conducted in the past few years on washed coal coke and on unwashed coal coke and also by some current blast furnace operations.

It is not possible to make direct comparisons between blast furnaces nor to forecast the probable benefits to one furnace from data obtained on another furnace operation, because although the quality of coke may be the same, certain other variables are introduced such as the quality and type of ore, quality of iron produced, etc.

However we can analyze the probable results and

Figure 4 — Centrifugal dryers for fine coal dewatering.



predict possible benefits and economies. If the ash and sulphur of the coke are held reasonably consistent and uniform, the blast furnace operator can reduce the amount of stone in his charge because he no longer has to provide for the peaks of high sulphur. This in itself will reduce coke consumption as well as reduce the amount of flux required and the slag volume will also be reduced. This reduction will permit the use of more ore and so increase pig iron output. The increase in the physical values of washed coal coke will be reflected principally in the manner in which the burden is carried in the furnace and this in turn will permit lower blast pressures and consequent power saving or will allow for an increased blowing rate and increased output.

Again referring to Seyler we find that the average operation of five different plants when changed over from coke made from unwashed coal to coke made from washed coal showed:

Coke consumption reduced	5 to 8 per cent
Flux reduced	5 to 10 per cent
Slag volume reduced	7 to 12 per cent
Blast pressure reduced	5 to 8 per cent
Pig iron production increased	5 to 8 per cent

When we consider that above benefits were obtained by reducing the ash in the coal from 8.62 per cent in the raw coal to 7.33 per cent in the washed coal with corresponding sulphurs of 1.11 and .99 per cent, we know that the benefits accruing from improving dirtier coals will be appreciably greater.

Among some of the coke plant and blast furnace operators there is a rough rule of thumb for every 1 per cent reduction in coke ash (above a base ash of 8 per cent) there is an increase in blast furnace production of about 5 per cent. The experience cited by Seyler seems to bear this out.

Studies made on coals now mined in the Pittsburgh district and ultimately used for blast furnace coke indicate that large savings are available in the cost of pig iron and that an increase in pig iron production can be had in present plants that may be as high as 15 to 20 per cent, by simply improving the preparation of coal used in making blast furnace coke. Furthermore, in certain cases where companies are being forced to mine a greater quantity of inherently higher ash and sulphur coal, unless the best preparation is used, there is a grave possibility that the blast furnaces will not be able to maintain their present rate of production.

This increased production can be obtained quickly and for a very nominal capital outlay, by the installation of well designed coal preparation plants, containing efficient washing equipment capable of obtaining the maximum cleaning of the finer coal and in particular the maximum removal of fine sulphur.

Such a program would take full advantage of the capabilities of present coke oven and blast furnace installations. To obtain equivalent increased pig iron production based on construction of new blast furnaces, coke plants and auxiliaries will require far greater capital investment, increased production costs, will require greater time and consume more of our vital war materials.

DISCUSSION

PRESENTED BY

W. T. BROWN, Research Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

G. V. WOODY, Allis-Chalmers Manufacturing Company, Pittsburgh, Pennsylvania.

F. M. BECKER, United States Steel Corporation of Delaware, Pittsburgh, Pennsylvania.

T. C. CAMPBELL, District Editor, Iron Age, Pittsburgh, Pennsylvania.

W. S. McALEER, District Manager, The McNally Pittsburg Manufacturing Company, Pittsburgh, Pennsylvania.

W. T. BROWN: Mr. McAleer has presented a very excellent and timely paper. The whole Pittsburgh coal seam in Fayette and Washington Counties is rapidly being depleted and we are going to have to go to Greene County, Morgantown and Fairmont district for our Pittsburgh seam coking coal. The coal in Washington and Fayette Counties runs about .8 per cent organic sulphur, but when we get into Greene County, it contains about 1 per cent organic sulphur and as we go farther south into the Fairmont district, it is about 1.20 per cent organic sulphur and the pyritic sulphur is higher. We have had quite a little experience with the Greene County coal, where we find everything wrong in the mines — rolls, horsebacks, boney coal and everything else that makes bad coal. The sulphur content runs up over 3 per cent, and with mechanical loading you get a great deal more ash, as well as high sulphur in the coal you mine. Greene County coal must be cleaned in order to make it suitable for by-product use.

We found that the high ash in the mechanically loaded coal seems to go with the lump sizes. If you clean the lump sizes, you reduce the ash but there is practically no reduction in the sulphur. The suphur seems to follow the fine sizes. By washing the fine sizes, you get about 35 per cent reduction in sulphur.

What is the advantage of cleaning coal? A high ash coke means less fixed carbon in the fuel for blast furnaces and more slag volume, which in turn means more coke per ton of iron and less iron production. High sulphur means irregular blast furnace operation, high slag volume, high sulphur iron, high coke per ton of iron and lower iron production. I believe that the coal cleaning plants not only will reduce the ash and sulphur but smooth out the irregularities and give you a better blast furnace coke, so that we can increase iron production in all the blast furnaces using this Pittsburgh seam and other coals.

G. V. WOODY: The idea of cleaning metallurgical coal is of course not particularly new and it has been the "theme song" of many of us, interested in coal cleaning, for a number of years. Several plants of course have been installed but, in general, we are glad to see

that the steel industry, who, perhaps, did not as a whole give this matter too much thought, seem to be giving it more attention. I think that Mr. McAleer made the statement that the uniformity of a cleaned or washed product, caused by the thorough mixing which it obtains in a cleaning plant, is one of the very important advantages to be derived. We do not mean to say, however, that it is the only important advantage of cleaning. I think Mr. McAleer covered the situation in a very thorough and excellent manner.

F. M. Becker: The changes which have taken place in sources as well as mining methods, as pointed out by Mr. McAleer, have resulted in progressive degradation in the chemical properties of coal for metallurgical purposes in the Pittsburgh district. Furthermore, according to forecasts, this trend will continue in the future. In general, coal quality degradation, in the past, has manifested itself by continuous increases in ash and sulphur content — although it is believed that the most pronounced adverse effect has been found from the disproportionally greater variability in coal quality resulting from the use of facilities to increase mine output.

With the use of mechanical facilities for loading coal in the mine, it is impossible to segregate the extraneous material which causes high and variable ash content if mine production rates are to be maintained. The lack of uniformity in the coal is to a large degree dependent on the extent of such inclusions and is directly proportional to the magnitude in which isolated quantities of high and low ash materials are present. If such coal is carbonized without further processing, it is to be expected that the regularity in chemistry of the coke will be similarly affected.

It has been found that the inclusion of slate particles above a certain minimum in coal form the nuclei for cross-fractures in coke. Accordingly, varying quantities of such materials will adversely affect the yield of furnace size coke, particularly when the coal is not finely pulverized prior to coking.

Variations in ash and sulphur together with associated differences in carbon content, adversely affect the value of coke as a metallurgical fuel by producing continuous changes within the blast furnace. Such changes can only be compensated for by alterations in furnace burdening, and since the frequency and severity of variations in sulphur, ash and calorific content of the coke cannot be adequately anticipated, it is difficult to maintain optimum production of pig iron to meet quality specifications.

Insofar as has been determined, the inherent ash content of Pittsburgh seam coal has been found to remain constant within reasonable limits. This is substantiated by the results obtained at various washing plants which show that the ash content of the overall washed Pittsburgh seam coal is approximately the same, irrespective of the mine location operated, in coal from this general source. Sulphur content, conversely, varies to a far greater extent, and comparatively wide variations have been experienced within small areas. Unfortunately, however, the variation in sulphur content is caused by an inherent quality which is characteristic of a definite location, and the extent to which sulphur can be removed or otherwise reduced by washing is dependent on the quantity as well as physical form of sulphur which exists in the coal as iron pyrites.

Adequate evidence is now available to indicate that the principal objective to be attained towards improving coke required for metallurgical purposes can be achieved by effecting a greater degree of uniformity in its physical and chemical characteristics. In most cases, this can be most readily accomplished by washing.

T. C. Campbell: I would like to put up three things to Mr. McAleer. First, will he agree that, with the draft and increased war production jobs which pay miners more money, the actual output per man of mining since the war began has dropped somewhere around 15 per cent for various reasons, including necessity to hire youths and older men, payday, holidays, and a few other things? Second, does he think that mechanical mining or mechanical loading in the districts covered by his talk will increase to some extent, and for that reason require more washing?

I would like to ask him also if he thinks the lack of such methods where indicated is not conducive to the best war effort, since we have to increase pig iron output. I would like to have Mr. McAleer say a few words on how washing equipment and washing techniques would produce more pig iron in the smallest space of time.

Another point, perhaps we should look into a future a little, as the last speaker said, to the degradation taking place in some western Pennsylvania coking coal. In the Pittsburgh district alone, in the case of one of the largest steel companies, after they have gone beyond 80 per cent of ingot capacity, the other 15 per cent is dependent entirely on the beehive coke supply, which is now being affected by the draft, other war jobs, truck strikes, and so forth.

During 1943, any increased output of pig iron in the Pittsburgh area due to new blast furnaces coming in will depend a great deal upon the type of coking coal for beehive plants which we get from the western Pennsylvania regions, which I understand is being rapidly depleted. Beehive plants have to go farther for their coking coal, the whole result being that if, as this paper presented it, coal washing is so effective that it can increase the production of pig iron by 15 per cent, then I think washing coal is the only answer to the present situation. You gentlemen probably know quite well enough what is going to happen to steel operations by next February or March if we don't get more metallics and it doesn't make a bit of difference whether they are in the form of pig iron or scrap.

W. S. McAleer: I would like to answer the gentleman as far as I can. There is no question but that the mechanization of mines is going forward by leaps and bounds and I think probably the limiting factor on that is the mining companies' ability to obtain the mechanical equipment. That is being forced by costs and by labor shortages and other things.

As far as the steel companies are concerned, and the increase in pig iron production due to washing coal, that is something about which it is hard to make a broad statement. That will vary from company to company, depending upon their location, their mines and the type of coal they are now producing, and the way they are producing it. But I do know that it is a fact, from some of the coals we have studied, that some of the companies can well anticipate at least a 15 per cent increase in pig production by washing coal.

CONSERVATION OF *Critical* MATERIALS IN *Transformer Design*

. . . . . as a result of developments over the past few years, one-fourth to one-third of the critical materials formerly used in transformer construction may be saved . . . . .

by **J. K. HODNETTE,** ENGINEERING MANAGER

Westinghouse Electric & Manufacturing Company

SHARON, PENNSYLVANIA

▲ PRODUCTION of materials of war have imposed unusual requirements on all American industries. Many of the materials necessary for this endeavor are also required in large quantities for normal domestic peacetime usage. Thus the pyramiding of requirements has resulted in shortages of many critical materials necessary for the successful production of the war.

Transformer equipments are necessary for the expansion and maintenance of production facilities because the transformer forms a necessary link in the transmission of electrical energy for the production of steel, aluminum, magnesium, and other necessary materials, as well as the processing of these materials into finished products. It is essential, therefore, that the transformers required for these purposes be built with the minimum possible usage of critical materials. The principal materials used in the construction of transformers are steel, copper, oil, and solid insulation. Steel and copper are at present very scarce and oil is rapidly becoming so.

The writer's company has recently completed some major developments which permit the construction of transformers with one-fourth to one-third less material than was formerly required. These developments are available now for contributing to the war effort; they have already saved about 1000 tons of copper and 4000 tons of steel since the start of the war. This paper describes some of these developments.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pennsylvania
September 22 - 24, 1942

Silicon steel was introduced into the manufacture of transformers in 1904. It marked the largest single improvement made in transformer construction and it opened a new field of research for the steel manufacturers. Great improvement in the quality of silicon steel was made as the mills developed the technique of melting, rolling, annealing, and the control of impurities. In the intervening years, a reduction in the core loss to one-fourth of its original value has been made, as indicated in Figure 1.

As the quality of the steel was improved, transformer designers were able to work it at higher inductions to obtain given losses and the result was a reduction in the size and cost of the transformers.

Superimposed on Figure 1 is a portion of a cost curve illustrating the improvement in costs of the core and coils of a 5 kva, 2400 volt transformer. It will be noted that the cost of the active material in the transformer was reduced roughly in proportion to the reduction in core loss until 1931. At that time a sharp flattening-out tendency of the cost curve was noticed. Analysis revealed that this was due to the fact that while the core loss of the steel was being improved, no improvement was made in the permeability or flux-carrying capacity of the steel. The point was finally reached where the exciting current of the transformer was determining the amount of material required. It became evident, therefore, that without improvement in permeability, further reductions in core loss would have little or no effect in reducing the material required or cost of transformers.

Research work was then directed towards the development of electrical steels in which the permeability and core loss were simultaneously improved. Experiments with single crystals of silicon steel indicated that they had unusual magnetic properties. Such crystals are cubic in form and they have high permeability when magnetized along the cube edges. This indicated the possibility of an orientation of crystals in sheet form which would maintain these properties; that is, it might align the magnetic domains and crystals in the sheet in a uniform pattern in contrast with the random arrangement in hot rolled silicon steel. From this work, "Hipersil" steel was developed. It is a high-permeability silicon steel having its crystals oriented in the direction of rolling and as a result having much lower core loss than previously used silicon steels. This desirable result was accomplished by developing an entirely new technique of rolling and heat treating in which the impurities in the steel as well as the processing cycles are rigidly controlled.

The opportunities for saving material in constructing transformers are apparent when magnetic steel with greatly improved quality is used. The new magnetic steel can carry up to one-third more magnetic flux in the finished transformer core without exceeding established efficiency levels, and it is applicable to all types of transformer apparatus from the smallest current transformer to the largest power transformer. By operating at higher induction the core section can be proportionately reduced in area, requiring less steel for the core. And then, with a smaller core section, shorter copper turns are required, making a corresponding reduction in the amount of copper in the coils. Finally, smaller and lighter frames, fittings, and tanks are necessary for the smaller core and coil units, thus saving oil and structural steel plate.

Transformer design is complex in nature because there are several degrees of freedom for a given performance. The size and length of the core can be varied over a relatively wide range as the cross section of the copper coils and the number of turns are varied. The designer strives to obtain the most efficient and economical physical proportions. For this reason, the ratio of copper to steel varies throughout the range of sizes; the reduction in weight of materials through the application of "Hipersil" steel also varies. The overall average saving in weight has been in excess of 20 per cent. Some examples of the saving in copper, magnetic steel, and total materials is shown in the chart, Figure 2. It is interesting to note that in the case of the 36,000 kva transformer, the total weight was reduced from 303,000 pounds to 266,800 pounds, thus saving 36,200 pounds of critical material.

It is also of interest to compare the saving in weight effected by recent improvements in silicon steel with those made in the past. Figure 3 shows the reduction in total weight of distribution transformers plotted against the years of manufacture. Reference should be made to Figure 1 to show the quality of the steel used.

The up-rating of electrical equipment as a step

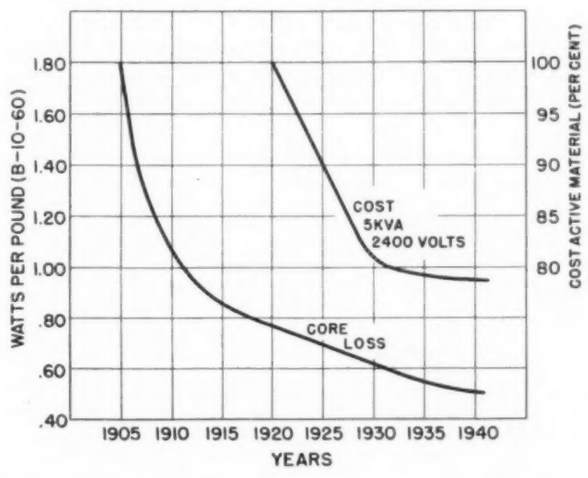


Figure 1 — Historic record of improvement in core loss of silicon steel.

▲

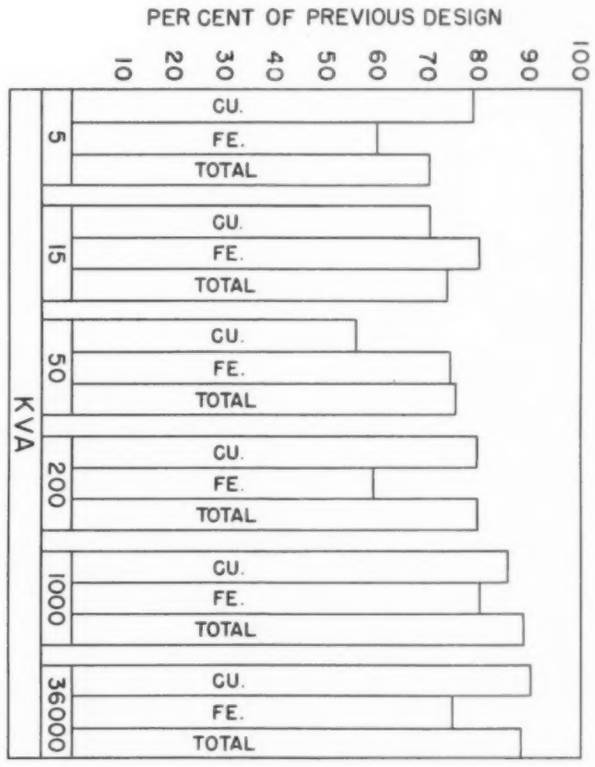


Figure 2 — Examples of saving in weight in copper, silicon steel, and total material in transformers by using hipersil steel cores.

towards conserving critical material is a problem of national importance. It is essential that existing equipment be overloaded as much as possible and still maintain safety against burnout or failure. Design and installation of new equipment should be made with due regard to the maximum capability of the apparatus.

So far as transformer apparatus is concerned, a great deal can be accomplished due to the fact that transformers inherently have a large thermal or overload capacity. The maximum output of a transformer at any time is limited solely by the temperature of the copper or the vital insulation surrounding the copper. The life of the insulation depends upon the temperature to which it is exposed and the length of the exposure. See Table I. The upper limit of Class A insulation for continuous operation was established at 105 C by the A. I. E. E. Since both time and temperature are factors influencing life, higher temperatures are permissible for shorter periods of time. Since service conditions seldom involve continuous operation at loads and ambient temperatures which establish maximum temperature limits for the insulation, latent capacity is practically always available.

The Transformer Subcommittee of the A. I. E. E., recognizing the above facts, have established tentative guides for operating transformers at greater-than-normal load with some sacrifice of life expectancy. (Guides for Loading Transformers and Regulators — A. I. E. E. Transformer Subcommittee Report — September, 1942.) Table I shows the recommendations for power transformers. It should be recognized that such general rules are limited by old apparatus having reduced margins of safety.

The difficulty in utilizing all the overload capacity of transformers in the past has been to exercise the proper control to prevent damage from excessive loading. Such overloading can be accurately controlled on new apparatus by the installation of a thermal relay calibrated to follow the copper temperature of the transformer winding. (Loading Transformers by Copper Temperature — Putman and Dann A. I. E. E. Technical Paper 38-122.) A simple and reliable relay, the type TRC, of the bimetallic type has been developed for this purpose. It is mounted inside the transformer case and it obtains its temperature response from the hottest oil and from a current proportional to the winding current circulated through the bimetallic element. By this means, the time-constant or temperature-time characteristic of the relay is made to assume the same form as that of the transformer itself for intervals beyond the inherent transient period of the relay. The relay then automatically takes into account all the factors which influence transformer temperature and accurately integrates them. In accordance with the transformer capacity, it permits comparatively high overloads for a short time and lesser overloads for a longer time.

A schematic diagram of the relay is shown in Figure 4. Current from the winding lead passes via the current transformer through the bimetal element. This current heats the bimetal and, in conjunction with the hot oil, causes it to deflect upwards. When the maximum safe operating temperature is reached, the first latch is released which gives a warning signal that the transformer is being overloaded. If the warning is not heeded and the load continues to increase, the second latch operates to disconnect the transformer from the line under the burnout temperature and prevent apparatus failure. The relay serves a dual function. It is an automatic guide for operation and a protective relay.

Most electrical loads are fluctuating in character; that is, there are peaks and valleys in the load curve. This is especially true of domestic and most central station loads. A typical domestic load cycle is shown in Figure 5. For such types of service, loading by copper temperature is ideally suited. The full capacity of the transformers can be utilized without hazard to service or equipment, whereas other systems of operation require high safety factors or elaborate control to prevent damage from overload.

When loading by copper temperature is employed, smaller transformers can be installed for a given peak load. This principal was first applied to CSP distribution transformers, where the next smaller size was applied in many cases with consequent saving in material. The TRC relay can be applied to new power transformers to equip them for similar operation with a degree of benefits depending upon the character of the load. As an example, consider the load chart, Figure 5. At least 3750 kva transformer would normally be applied, whereas a 3000 kva transformers equipped for

TABLE I

SHORT TIME EMERGENCY OVERLOADS

TRANSFORMERS RATED ABOVE 500 KVA

Duration, hours	Times rating Following full load		Times rating Following no load		Hot spot thermometer* degree C
	S. C. and W. C.	Forced air	S. C. and W. C.	Forced air	
1	1.9	1.6	2.0	1.8	137
2	1.7	1.45	2.0	1.6	130
4	1.5	1.35	1.7	1.4	125
8	1.35	1.25	1.45	1.25	120
24	1.25	1.15	1.25	1.15	110

* Temperature and time values represent a sacrifice of life of not more than one per cent for each emergency operation.

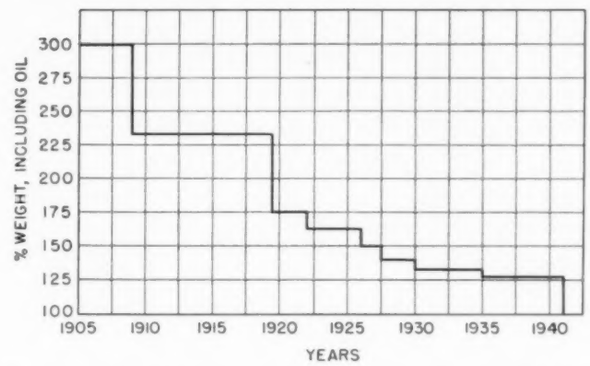
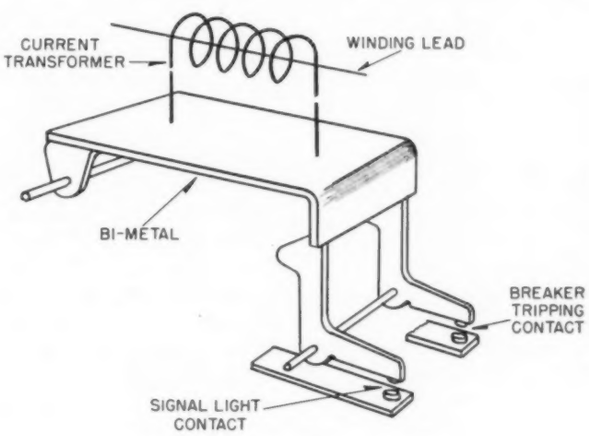


Figure 3 — Historic record of reduction in total weight of material in distribution transformers.

▲

Figure 4 — Schematic diagram of TRC thermay relay.



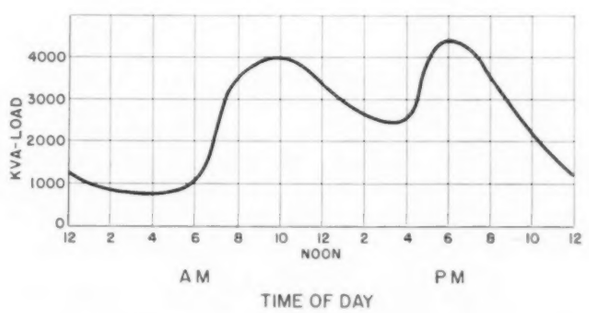


Figure 5 — Load cycle chart for distribution circuit.

loading by copper temperature has sufficient capacity to carry the load. The smaller transformer would require 17 per cent less steel and 15 per cent less copper, a saving in critical material of 5250 pounds. In addition, when new installations of this size are required, automatic unit substations or CSP power transformers can be employed, effecting a further large saving in space and structural materials for the substation.

When a transformer winding carries current, heat is generated in it and raises its temperature. This heat is conducted through the insulation on the conductors to the oil and by convection from the oil to the radiators. In self-cooled transformers, thermosiphon action causes the oil to flow through external radiators and the heat is carried off by the surrounding air. The heat is dissipated both by direct radiation and by convection.

It is a well known fact that a film of air is absorbed on the surface of metal radiators and this film of air retards the flow of heat from the radiators. If air is forced over the radiators by means of a fan at high velocity, the film of air on the surface is partially scoured off by the turbulent action of the air and the rate of heat transfer is increased. In other words, when air is blown across the radiators of a transformer, the heat efficiency is increased and the load that can be carried for a given temperature rise is increased. This increase of load is from one-fourth to one-third, depending upon the size of the transformer.

The action that takes place in transferring the heat from the conductors to the oil inside the transformer is analogous to transferring the heat from the radiator to the air. As heat is transferred from the coils to the oil, the oil becomes hot and rises through the coil ducts. Due to the viscosity of the oil, the speed at which it flows as a result of this action is quite slow and consequently a relatively thick film of oil adheres to the coil surfaces and retards the flow of heat from the coils. For this reason, the temperature gradient between copper and oil is consumed largely in the oil film, approximately 80 per cent of the temperature drop being in the oil film. Forcing the oil through the coil ducts at high speed removes most of this film and greatly reduces the temperature gradient between copper and oil. For example, the total temperature gradient can be reduced by one-half by forcing the oil through the ducts, thus allowing the transformer to carry a greater load for a given temperature rise. It is common in power transformer design to use gradients of 10 C or more. Thus a reduction in gradient of 5 C or more is effected.

There is another factor which works in favor of forced-oil cooling. The maximum hottest-spot temperature in the transformer limits the load that a given transformer can carry. With normal thermosiphon flow, the difference in temperature head between the top and bottom of large transformers is 15 to 20 C. By force-circulating the oil, this difference in temperature is reduced to one or two degrees. Furthermore, the hottest temperature is in the coil under the spacing ducts. Decreasing the surface gradient of the coil means that the heat generated in blanketed sections has a shorter length to flow and the hottest temperature is thereby reduced to a matter of two or three degrees above the average copper temperature. All of this means that more load can be carried without exceeding the hottest-spot temperature. On large transformers, forced-oil circulation increases

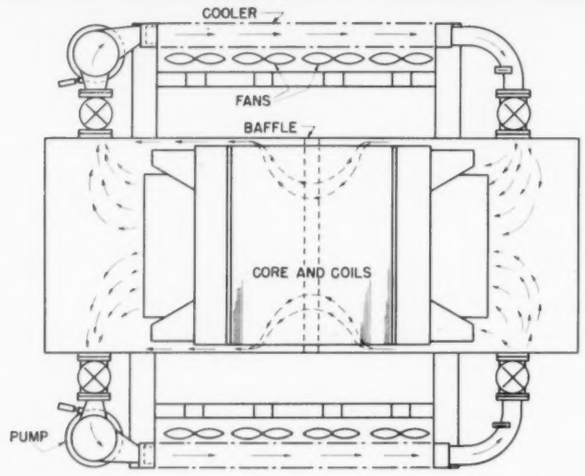


Figure 6 — Diagram of cooling system of forced-cooled power transformer.

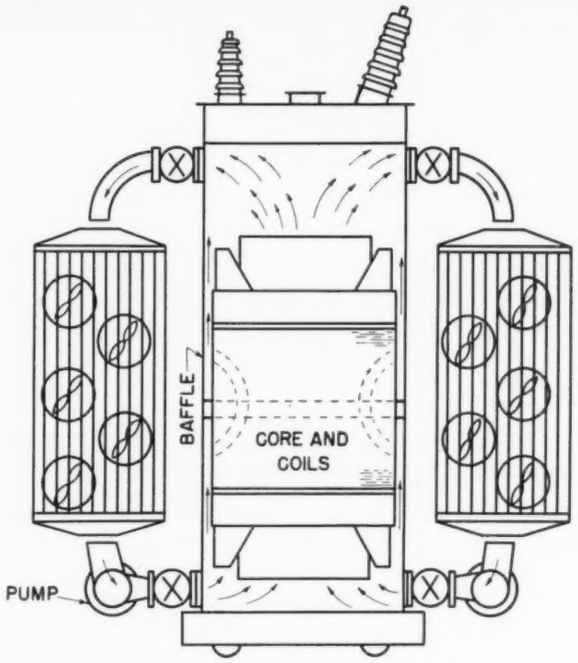


Figure 7 — Diagram of cooling system for triple rated (self-cooled, forced-air-circulated, forced-oil-cooled) power transformers.

the output capacity of a transformer approximately one-third and, as pointed out above, forced-air cooling also increases the rating one-fourth to one-third. Combining these two methods of cooling, the capacity of a transformer can be increased approximately two-thirds of its base or self-cooled rating.

To apply forced-oil cooling to power transformers, only slight modifications of construction are required. The core and coils are of the shell form of construction with normal insulation and bracing. Baffles are required to direct the oil flow through the coil ducts and with sufficient leakage to carry off the losses in the iron core.

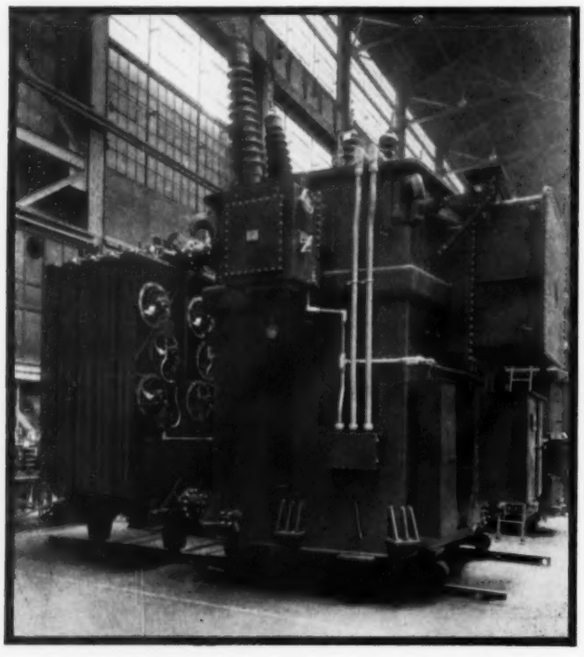


Figure 8 — Photograph of 16,667 kva triple rated transformer showing arrangement of cooling system.

In addition, oil flow through the coil sections is balanced in proportion to the losses or heat generated in the various sections.

There are two types of designs available. For base-load stations simple forced-cooled transformers are applicable. The construction of this type of transformer is shown schematically in Figure 6. Here oil is forced through dual coolers by two independent pumps and thence through the coils. The coolers may be of either the forced-air or oil-to-water type. This transformer has no self-cooled rating but, depending upon the load, one or both pumps must run at all times. Protective relays are provided to turn the fans on and off, sound an alarm in case of pump stoppage, and protect the winding from burnout due to overload or equipment failure. This type of construction represents the maximum possible saving in copper, steel, and oil for a given output. Compared to a self-cooled transformer of equal rating, a reduction of as much as 45 per cent in weight of material can be made.

The second type of transformer is triple rated and is suitable for more widespread application where large amounts of power are required now but normal requirements are less. These transformers have a self-cooled, an air-blast, and a forced-oil-circulation rating. Take as an example a transformer with a self-cooled rating of 15,000 kva. By forced-air circulation across the radiators, the load can be increased to 20,000 kva; by pumping oil through the coils and external radiators in addition, the load can be increased to 25,000 kva. A

diagram of the cooling system is shown in Figure 7 and a photograph of a 16,667 kva unit is shown in Figure 8. This type of transformer is similarly protected from overload burnout by thermal relays. The fans for forced-air circulation are turned on and off by means of a thermostat operating on oil temperature. The pumps are turned on and off by means of a thermal relay operating on winding temperature. The circulating and protective equipment is of proved reliability.

As can be seen, the forced-cooled triple-rated transformer provides enormous overload capacity above the self-cooled rating for emergency condition or for extended periods, without decreasing the operating reliability. In addition, such a forced-cooled triple-rated transformer can be built with 30 per cent less copper and silicon steel, 28 per cent less structural steel and 26 per cent less oil than a self-cooled transformer of equivalent maximum rating. For example, 68,100 pounds of material are saved in building a 21,000/28,000/35,000 kva transformer, with only an increase in loss at maximum rating from 195 to 268 kw as compared with a self-cooled transformer.

In recent years many innovations have been introduced into transformer design and construction directed towards obtaining more economical transmission and use of electrical energy, greater apparatus reliability, and lower maintenance cost. The three developments described above contribute largely towards achieving this goal. They can be coupled together or used in conjunction with other design ideas now to save vital critical material in transformer construction.

DISCUSSION

PRESENTED BY

K. B. McEACHRON, Designing Engineer, General Electric Company, Pittsfield, Massachusetts.

H. H. WAGNER, Electrical Engineer, Pennsylvania Transformer Company, Pittsburgh, Pennsylvania.

J. S. MURRAY, Chief Electrical Engineer, Follansbee Steel Corporation, Follansbee, West Virginia.

J. K. HODNETTE, Engineering Manager, Westinghouse Electric and Manufacturing Company, Sharon, Pennsylvania.

K. B. McEACHRON: In these days, when everyone bears abnormally high load, the preparation of as well thought out and timely paper as that of Mr. Hodnette's is a contribution that should be particularly valued and we all should be grateful to Mr. Hodnette for his efforts.

In time of peace, the convention floor should be and generally is used to present diversity of views and methods of various industrial groups. Under the present circumstances, however, it is the unity that is needed and must be sought.

Since the availability of several sources of supply of essential equipments is now more important than ever before, the industry should find comfort in the fact that transformers with characteristics described by Mr. Hodnette, can be secured from more than one source.

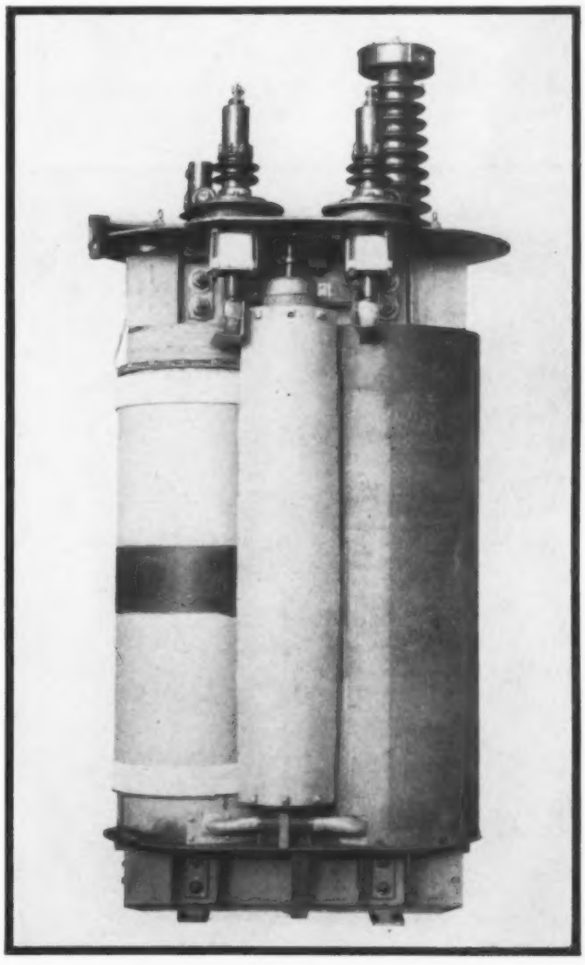
The paper presents three important accomplishments in transformer field so well and so broadly that it can be looked upon as a report of transformer manufacturing industry to its customers.

I am happy to endorse it in all three respects that is, the use of cold rolled steel for transformer cores, loading transformers by temperature, the use of forced circulation of oil and air (or water) as the most effective methods of saving essential transformer materials.

How far-reaching the saving in steel is promised by wider use of cold rolled process can be seen from the fact that in distribution transformers where this type of steel has been used for the last five years, enough steel has been saved to build more than a year's supply of such transformers, something over a million pounds.

It is gratifying to learn that cooling of transformers by forced circulation of oil and air is easily adaptable to shell type or interleaved winding type of transformer as described by Mr. Hodnette. However, since the bulk of transformers manufactured in this country and in the world is of the core type with concentric windings,

Figure 1 — Internal view of large power transformer of core type cooled by forced circulation of oil and air.



it is indeed fortunate that the same type of cooling has also been successfully applied to the core type with a similar saving in materials.

Figure 1 shows internal view of large power transformer of core type with concentric windings cooled by forced circulation of oil and air, built several years ago preceding the broader application of such a cooling to stationary power transformers that has taken place during the last couple of years.

As a result of the experimentation on this transformer, we have built and have on order a matter of 650,000 kva of power transformers with this type of cooling of a variety of sizes, from 40,000 kva down. Seven transformers of this size have been shipped.

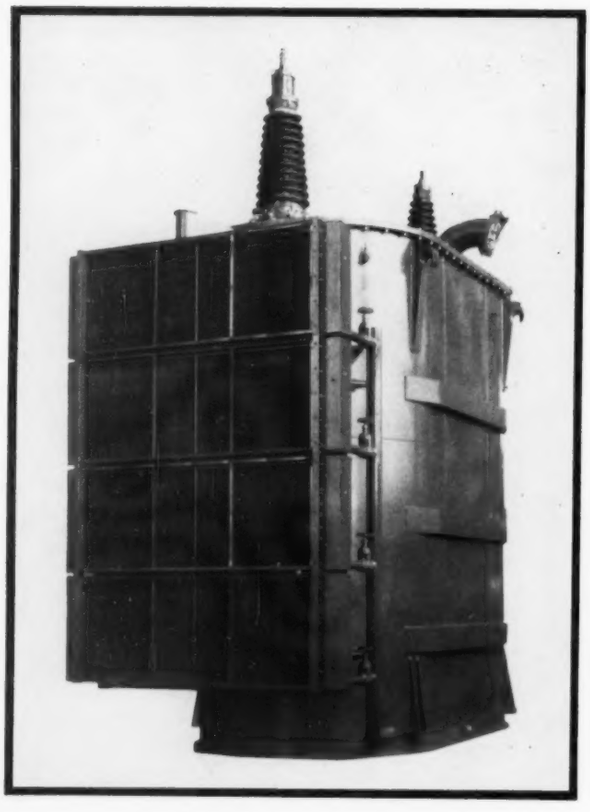
With the introduction of this new type of cooling, transformer user has the following choice:

Oil	*Air*	*Water*
1. Free convection	Free convection	None
2. Free convection	None	Forced convection
3. Free convection	Forced convection or	None
4. Forced convection	Forced convection or	None
5. Forced convection	None	Forced convection

In addition to these, water spray on the air cooled radiators has been used on occasions.

It is obvious that many combinations of the five types can be used. Such an example, is illustrated by Mr. Hodnette's Figure 7, where one and the same transformer is cooled by method No. 1, 3 and 4, depending on the load.

Figure 2 — External view 40,000 kva transformer cooled by forced circulation of oil and air.



In regard to the loading by temperature, again manufacturers and transformer users agree that transformers can be loaded in accordance with Table I of Mr. Hodnette's paper. This table was prepared by the A. I. E. E. Transformer Sub-Committee.

Figure 2 shows external view of a 40,000 kva transformer cooled by forced circulation of oil and air.

In applications where dependance is placed on the action of high velocity oil flow within windings, sufficient factors of safety must be allowed to take care of variations in oil flow since unknown or unanticipated reductions in oil velocity though small, may give rise to serious overheating in local spots. The designer must pay special attention to the temperature under spacing strips, and be sure that oil in sufficient quantities reaches all parts of the winding.

H. H. WAGNER: This paper outlines three important developments which may be applied to new transformer designs for conservation of material. Of these, the one resulting in the greatest saving of materials is that of forced-oil cooling.

Forced-oil cooling has been used in Europe extensively since the first World War due to the scarcity of materials. While it has been used in this country for many years, it is not as widely applied as self-cooling or water-cooling. As has been shown in this paper, the use of forced cooling offers a very great advantage in saving of materials as compared to the conventional self-cooled transformer.

As a further example of the comparison of the materials required for cooling by ordinary forced-oil cooling and by self-cooling, our company built a 15,000 kva, 25 cycle, forced-oil cooled furnace transformer which used a cooler or heat exchanger which weighed 1,500 pounds, including the oil pump. If this transformer had been equipped with radiators for complete self-cooling, the radiators would have weighed 43,000 pounds and the oil to fill them would have weighed 15,000 pounds, which results in a total weight of 58,000 pounds for the cooling system. Thus, the use of forced-oil cooled construction required 56,500 pounds less material, or a saving of 97 per cent in the weight of the cooling equipment.

The use of forced cooling in combination with the forced circulation of oil through the transformer coil ducts as described by Mr. Hodnette can be applied to transformers of all sizes. By means of a similar arrangement, we have built portable substation transformers in sizes as small as 500 kva which had a weight of copper and core steel of approximately 60 per cent of conventional designs.

In addition to the methods described, which may be applied to new transformer designs, the transformer manufacturers, through the N. E. M. A., have made suggestions to the War Production Board and to users of transformers whereby existing transformers now in service may carry higher loads and thus reduce the necessity for buying additional transformers.

Some of the important suggestions from the N. E. M. A. report are as follows:

1. Addition of blower equipment to O. I. S. C. transformers for increasing the load up to 33⅓ per cent.
2. Addition of external forced-oil cooling, using heat exchangers either air-cooled or water-cooled.
3. Addition of water-spray to O. I. S. C. transformers.

4. Taking advantage of average daily cooling medium temperature, a transformer may be overloaded 1 per cent for each degree the average cooling medium temperature is below 30 C, providing the maximum temperature of the cooling medium at no time exceeds 40 C.
5. Taking advantage of the many cases where the average loading is below the peak load, a transformer may be overloaded 3 per cent for each 10 per cent the daily average load factor (ratio of average load to peak load) is below 100 per cent down to a load factor of 50 per cent.

More complete discussion of these suggestions, together with tables and curves, has been incorporated into A. I. E. E. Technical Paper No. 42-156, entitled "Interim Report on Guides for Overloading Transformers and Voltage Regulators," which is available from A. I. E. E. headquarters and also is published in Electrical Engineering, September, 1942.

In conclusion, it is recommended that, in cases where auxiliary cooling equipment or emergency overloading is to be applied to existing transformer installations, the user should check with the manufacturer of the transformers as to the overload capabilities.

J. S. MURRAY: My discussion on Mr. Hodnette's very excellent paper will be based on my experience as a user of power transformers and also as the representative of my company, who have been manufacturing silicon steel for some 35 years.

This paper illustrates the very remarkable progress that has been made in transformer engineering in a short span of 50 years, and with due modesty, I believe it can be said that the producers of silicon steel in the United States have contributed considerable to this progress, as illustrated in Figure 1 of Mr. Hodnette's paper. In any event, Professor Stanley's original transformer has had a remarkable life, and of course, we all agree with the vital contribution which the a-c system and the transformer has made to the progress of the electrical industry in the United States in a comparatively short lifetime.

It is especially significant in the case of Mr. Hodnette's paper that the electrical characteristics of the core material as developed by his company has resulted in such remarkable saving in vital materials, such as steel and copper, when such conservation is so necessary to the successful prosecution of the war.

In Mr. Hodnette's description of Figure 1 of the paper, he very properly mentioned that prior to approximately 1931, the cost of active material in the transformer was reduced, roughly, in proportion to the reduction in core loss of the core material, and also that at that time the curve flattened out sharply due to the fact that there was need for improvement in permeability of the silicon steel in the core if the cost and size of transformers were to continue to be reduced. Of course, the producers of silicon steel were aware of this and considerable experimental work was and is being carried on along this line of improving the permeability of the core material, as well as other efforts to reduce the core loss.

Mr. Hodnette's description of the crystal formations in the conventional hot rolled sheet is remarkably clear, and we might say without question that this has been the basis of the activity on the part of the various silicon steel producers to bring about orientation or alignment both in the conventional hot rolled sheet method of rolling as well as experiments of cold rolling with intermediate heat treatments. Some of the producers of silicon steel have produced such sheets for several years, some of which involved the addition of alloys, and at least one of the producers of silicon steel has been instrumental in working with the very marked progress made by the research engineers in the development of core material discussed by Mr. Hodnette.

We would like to point out, however, that this Hypersil material, as well as all other experiments, and production of similar material, are based entirely on the premise that the flux will travel in the direction of rolling, that is, with the grain of the material, and we believe that the design of the cores will have considerable to do with the success of this material in utilizing it to its best advantage in this manner. To illustrate, we might state that transformers have been improved in some instances where the conventional hot rolled

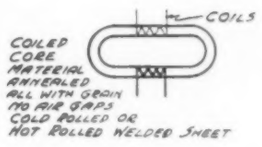


Figure 1

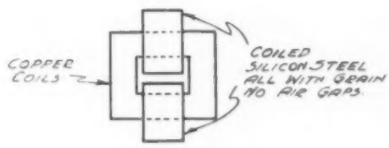


Figure 2

Figure 3

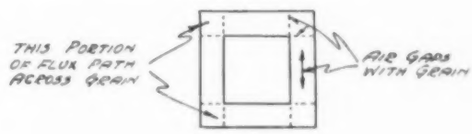


Figure 4

silicon sheets were slit and welded, all in the direction of the grain, and wound into circular cores, after which such annealed cores were equipped with transformer windings as shown in Figure 1, while in another case the silicon strip material was wound on the copper coils of the transformer itself as shown in Figure 2. In other instances, the conventional hot rolled sheet was slit in the direction of the grain with staggered joints, after which the coil was wound on these strips and bent into conventional transformer cores, where the staggered joints produced so-called tangent air gaps as shown in Figure 3. Also, Figure 4 shows the conventional transformer core in strips with interleaved laminations in the usual manner.

Having reference to these sketches, we would like to ask Mr. Hodnette what results he might expect from the use of this Hypersil material in conventional cores, Figure 4, where a portion of the material would be used across the direction of rolling in the path of the flux as compared to the transformer designs discussed in this paper.

Also, are there any alloys in Hypersil, such as nickel, or any other alloy that would contribute to the very high permeability which is possible from this method of manufacture?

What are the average core losses available in this material at, say, 60,000 and 90,000 lines per square inch? And in like manner, what are the permeability values available at these densities?

Are the silicon ranges employed in this material as high as those employed in the conventional hot mill sheet? How is the material affected by cold working?

It is assumed, of course, that the ductility of this Hypersil is superior to hot rolled sheets.

The high permeability characteristics of Hypersil, from the indications mentioned in this paper at least, seem to have other wide fields of application in addition to power transformers, such as small transformers for communication work, metering and relaying apparatus, etc. We believe it should be mentioned, however, that for rotating apparatus the use of a material similar to this has decided advantages, particularly for interpoles in large size variable speed d-c motors, and of course, many other applications. But the point to remember is, that its grain directional properties being paramount, it is not as useful in rotating apparatus generally as might appear on the surface. Of course, it is well known that several producers of silicon steel have produced directional grain material for rotating apparatus, primarily for better gauge control, superior punching quality and lower exciting currents.

Mr. Hodnette's description of the loading by copper temperature method of power transformers is one which we believe is very timely, and we would like to know if the type TRC relay discussed by him in the paper could be added to existing transformers of fairly recent design.

When discussing a subject such as this, keeping in mind the limits of 105 C set by the Transformer Committee of A. I. E. E., we are wondering what has been done in applying Class B insulation to transformers and what might be expected from such insulation in ultimate ratings by the industry as a whole.

Also, what is Mr. Hodnette's opinion or information on the types and maximum ratings of air-cooled transformers which may be available with Class B insulation rated at 75 C instead of the conventional 55 C rating?

Mr. Hodnette's description of forced air cooling of radiators and forced oil cooling, as illustrated in Figures 6 and 7, while not new in transformer loading, is extremely timely. It would be interesting to know how much this cooling has affected the rating shown in the paper, and at what cost.

J. K. HODNETTE: This paper covers a very broad subject and in a short treatment of this subject it has been impossible to cover many of the developments which the transformer industry has contributed. I am, therefore, indebted to Messrs. McEachron and Wagner for their discussions which give additional material on the subject. Mr. Wagner has given the suggestions to transformer users whereby existing transformers now in service may carry higher loads. These should be useful to transformer operators and they have the endorsement of all the transformer manufacturers.

I heartily agree with Mr. Murray that the steel industry has been largely responsible for the improvement in electrical apparatus as reflected by the improvement in silicon steel. The steel industry has done a magnificent job in research and development of steel for electrical machinery and they are deserving of full credit. Outside of the advancements made in insulating materials and manufacturing technique, the reduction in weight of transformers has been due largely to the improvement in the quality of silicon steel, and the development of the welding art. This improvement is illustrated by the figures in the paper.

Mr. Murray points out that hot rolled silicon steel has improved quality in the direction of rolling. This has been recognized and many of our larger transformers have been constructed of laminations cut in a manner so as to take advantage of this property. There is approximately ten per cent less loss in the steel when the flux flows in the direction of rolling but there is little improvement in permeability.

The Hipersil steel discussed in the paper is a silicon steel material having a high degree of orientation in the direction of rolling. It is particularly adaptable for transformer applications since it has a very high permeability at high inductions. This property is obtained by processing and purification of the material. It contains no other alloy magnetic materials such as nickel. The range of silicon employed in Hipersil is the same as for other silicon steels.

Since Hipersil steel is highly oriented, it is necessary to employ a type of construction in the manufacture of the magnetic core which will permit the flux to flow in the direction of orientation. The necessity for doing this is best illustrated by the fact that transformer cores constructed of conventional I-plates of Hipersil show little improvement over ordinary silicon steels since the flux must make a right angle turn at the ends of the I-plates.

In addition to being highly oriented, Hipersil steel is also very sensitive to mechanical strains and the type of core construction must be such as not to introduce mechanical strains after the material has been annealed. Two types of construction have been developed which

satisfy the above requirements. For small transformers, the steel is cut into strips and wound into rectangular cores. These cores are annealed, impregnated, and cut in two in order to receive the copper coils. This is the only type of construction which permits obtaining the full value of the improvement in loss and permeability of the steel.

The other type of construction which is used on large transformers is to stack the cores of laminations, mitered at 45 degrees at the joint. Alternate layers are overlapped to provide greater mechanical strength.

Hipersil steel is applicable to all sizes of transformer cores from the smallest radio transformer to the largest power transformer. Two 75,000 kva three phase transformers have recently been manufactured using Hipersil steel for the cores with a great saving in copper and silicon steel over what would be required if ordinary silicon steel were used.

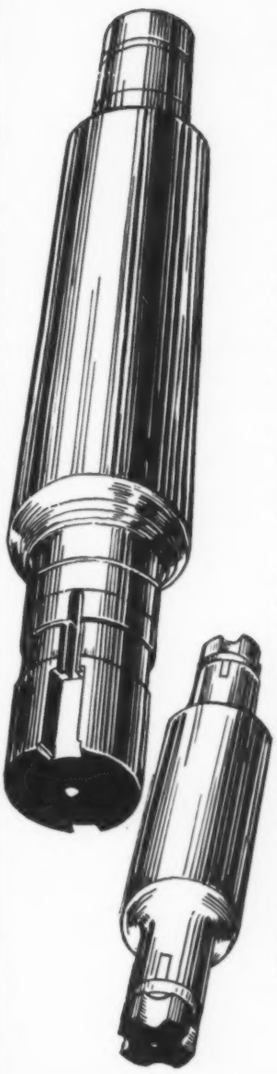
Mr. Murray asked if the type TRC relay could be applied to existing transformers of fairly recent design in order to provide loading by copper temperature. This can be done provided sufficient space is available inside of the transformer for mounting the relay and the current transformer if no bushing type current transformers are available. Some engineering work is required but with the characteristics of the transformer known, application of the relay can be made in a suitable shop in the field.

Mr. Murray requested information on the size of air cooled transformers available. Due to the increasing demand for such transformers for application in factories and buildings, the size has been steadily increasing until at present they are supplied in sizes of 2500 kva single phase and 3750 kva three phase with voltage ratings up to 15,000 volts.

Forced cooling of transformers is not new but like many other developments has waited upon the development of satisfactory auxiliaries. With reliable leak-proof pumps and rugged reliable protective relays, forced oil cooling can now be generally applied to power transformer equipment. As pointed out by Mr. McEachron, forced cooling can be applied to core type transformers. However, our company has adopted the shell type of construction since the flow of oil can be directed against both sides of the coils and avoid heating in local spots.

LOFTUS ENGINEERING
Corporation
1620 OLIVER BUILDING PITTSBURGH, PA.
BRANCH OFFICE
519 HOLLINGSWORTH BLDG. LOS ANGELES, CAL.
Engineers — Consultants — Contractors
Designers and Builders
of
MELTING • HEATING AND
INDUSTRIAL FURNACES

NATIONAL ROLLS



Soldiers Without Steel Are Without Power

WAR is now mechanized. Military leaders, while bowing to courage and morale as the strongest spiritual weapons of combat, know also that human strength must be supported by that of the machine.

That means steel, and steel means rolls. Strong rolls, the basic implements in munitions production.

We feel our obligation in producing NATIONAL ROLLS, in both iron chill and grain types, to have them serve as never before. And never before have their heat-timing, alloy proportioning, casting and finishing been so carefully watched, and we are encouraged in this by their performance in the mills.

Our officials and workers, like all others in the steel industry, feel they are helping to hasten Victory and peace for all.

THE NATIONAL
ROLL & FOUNDRY CO.
Rolls & Rolling Mill Equipment
AVONMORE, PA.

Sheet and Tube

New Modern

▲ COMPLETION of the new and modern sintering facilities recently placed in operation at the Campbell, Ohio plant of The Youngstown Sheet and Tube Company will aid in increasing, materially, the daily output of the blast furnaces in the Youngstown district.

The new plant, which has a rated daily capacity of 2,400 tons of sinter, is located directly east of, and is an integral auxiliary of, the Campbell blast furnace unit of the company.

The functions of this plant consist of combining flue dust and fine ores which because of their physical size make them impractical to charge directly into the blast furnace; then processing these materials and making them coherent by heating the properly prepared material to a partial fusion point while a strong air stream is passed through the mass thereby forming air cells or pockets throughout the entire mass. The particular advantage in the use of properly prepared sinter is increased output and reduction of fuel consumption in the blast furnace plus the recovery of valuable raw materials which otherwise could not be used.

The plant was located and designed to process fine lake ores, together with the dust from the dry dust catchers which are located at the blast furnaces.

The blast furnace larry track which carries the larry cars servicing the blast furnaces with necessary raw material was extended as a trestle track to the site of the new plant. A 50 ton larry car driven by a gas locomotive delivers the ores to a trestle hopper. Other materials such as flue dust, coke breeze and scale are delivered on a low level, standard gage track and placed in a track hopper preparatory to being processed.

Feeders at the bottom of these hoppers deliver material, in proper proportions, onto a gathering belt which discharges to an elevating belt conveyor. This elevating belt conveyor is located outside of the plant proper and is approximately 197 feet long. The burden from this conveyor is discharged onto a 5 ft x 14 ft vibrating screen which removes all material over ½ in. in size. The trestle hopper feeder belts and the feeder belts from the track hoppers may be operated separately or together in order that ore and flue dust may be blended in any ratio desired, by controlling amount of feed from each hopper.

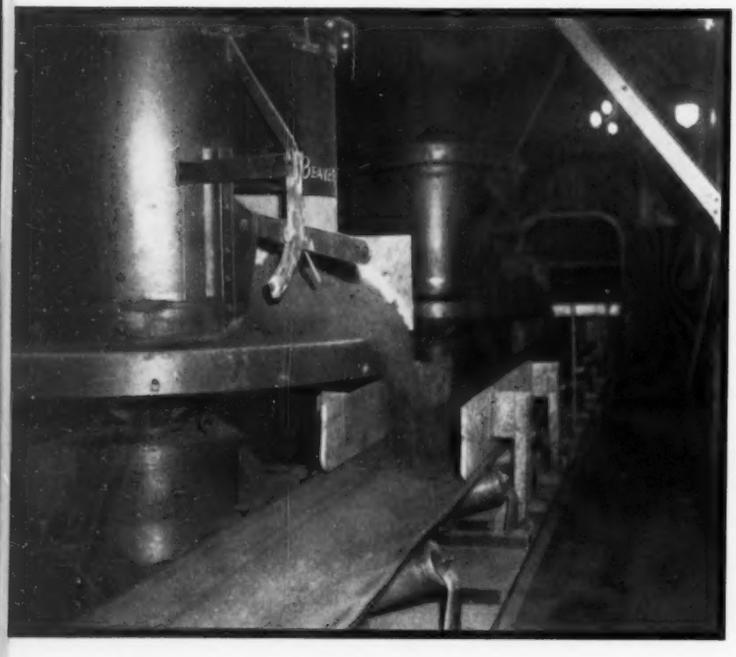
The over size material passes through a chute to cars and is sent to the open hearth furnaces or the blast furnaces. The fines which pass through the screen fall on another belt conveyor, approximately 64 ft long, and are discharged onto a shuttle belt conveyor which is located above and over the storage bins. By moving this shuttle conveyor back and forth the material may be placed into any one of the seven storage bins which are located on the inside of the plant proper.

These raw material storage bins are 19 ft in diameter and have a nominal capacity of 450 tons each. Since there are two sintering machines in this plant there is a separate feeder system for each of them, located on opposite sides of the storage bins; thus different grades of sinter can be made at the same time, or different grades of material may be charged allowing each machine to operate at best speed and desired depth of material on the grate bars.

Under each bin there is a revolving table serving as a circular disc feeder driven by a 600 to 1800 rpm adjustable speed motor. From this point the flow of material is independent for each sintering machine.

Any combination of bins may be placed in operation discharging their burdens upon the belt conveyors at one time. The amount of material flowing from each bin is controlled by means of a sliding gate. Therefore, by discharging from two or more bins and controlling the flow of material any mixture of materials with any percentage of each material can be obtained in the sinter mix; for example, two different types of ore, each combined with a given proportion of flue dust, which was blended on the conveyor belt at the trestle hoppers can now be mixed in predetermined percentages and then combined with the desired percentage of coke breeze. The belt conveyors at the storage bins are 24 in. wide and approximately 185 ft, 8 in. in length.

Figure 1 — Materials to be sintered are blended from bin hoppers on to the conveyor belt in any desired ratio.



Now Operating Sintering Plant

..... typical of the installations which have contributed so much to blast furnace production is this sintering plant built by Sheet and Tube at Youngstown .....

The material mixed in proper proportions is discharged onto another belt conveyor located at right angles to the conveyor carrying material from the storage bins and is deposited into a hopper at the primary pug mill along with screenings from the finished sinter which are known as "return fines."

These "return fines" are fed out of a hopper, under the sinter screen located at the discharge end of the sinter machine, by a magnetic vibrator conveyor. Dust which is automatically dumped from dust collectors and spillage from head and discharge end of sintering machine is discharged, also, into hopper at the pug mill.

While the volume handled by this belt conveyor is small it is important to keep the material moving to the pug mill in a constant proportion. Surges of wet and dry material produce an unknown factor and since the operator would be unable to compensate for changes the uncontrolled operation would result in substandard sinter.

The pug mill mixes the material delivered from the hopper which is located directly above it. Water is added as necessary. From the pug mill the mixed material is elevated by belt conveyor to a junction feeder from where it is discharged on another belt conveyor and further elevated to the "fluffer" where the material is thoroughly mixed and final moisture tempering accomplished. This method of mixing presintered materials makes it possible to produce a sinter suitable to any grade of iron. The "fluffer" which is located directly above the charging end of the sintering machine discharges the prepared material directly into a swinging chute which spreads it uniformly on the pallets of the sintering machine.

The sintering machines which are approximately 87 ft long with grate widths of 72 in. follow the conventional design. For each machine there is a series of pallets each designed to carry grate bars which form a bed on which the sinter lies. These pallets form an endless carrier, driven by a sprocket at the charging end of the machine, which make a continuous return system.

Material which has been deposited on the slowly moving pallets by the swinging chute is levelled to the desired depth by a stripping plate and then passes under an ignition furnace. This furnace consists of a series of coke gas burners supplied with high pressure blast air making them literally blow torches in their functional operation.

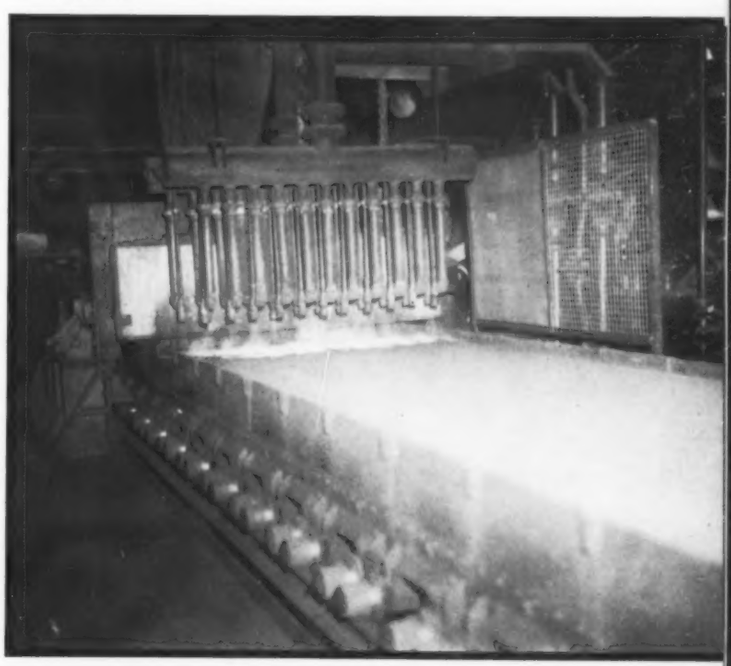
As the material passes along the machine, — which is driven by an adjustable speed-motor giving a variation in pallet speed of from 4 to 12 fpm, — the suction from the draft system, consisting of twelve wind boxes located beneath the pallets, produces a sufficient flow of air, downward through the bed, continuing combustion.

The correct mixture of materials is important and the right amount of carbon must be supplied to complete the sintering operation by the time the material reaches the discharge end of the machine. The carbon percentage is controlled by the blending of varying amounts of coke breeze or other fuel.

Ore to be sintered correctly must contain a sufficient amount of carbon as otherwise it would not be possible to produce the necessary combustion temperature required to give satisfactory output and efficiency. The sintering machine operator has facilities for producing uniform sinter of the desired hardness and porosity.

Finished sinter is discharged from the end of the machine onto a double deck bar screen and is delivered to a sinter pit under an open-yard crane runway from

Figure 2 — The coke breeze in the bed of material is ignited by gas burners at the furnace end of the sintering machine.



where it is loaded either into standard gage cars at ground level, or into a larry car on a trestle track by a 20-ton crane and grab bucket.

The down-draft system consists of the twelve wind boxes which are connected to primary dust catchers by down-comers. Gases are taken off at the top and then pass through two dust catchers and then onto the induced draft fan. The dust and return fines which are collected in this system are returned to the pug mill as described previously.

The fans which produce the draft with which this system is operated have a capacity of 140,000 cfm of air at a 25 in. static head.

Each of these fans is driven by 1250 hp motor at 720 rpm. These fans have a greater capacity than any other used in installations of this character at the present time.

The auxiliary equipment in the completed sintering facilities include: motor room which houses the fan motors, transformers and switch gear, drinking water coolers, a modern locker and wash room, etc.

The electrical power for this plant is transmitted underground from the main power house through two 400,000 cir mils lead covered cables at 6,600 volts, 60 cycle.

The down-draft fan motors are 6,600 volt, 3 phase, squirrel cage type, equipped with across the line oil circuit breaker control. A bank of transformers is installed in the motor room which supply the 220 volt power for the auxiliary operations in the plant. The oil circuit breakers and the a-c feeder panels along with a section of auxiliary control panels, are installed on the second floor of the motor room.

The motor and control room is constructed as a closed system in the interest of overall economy from the maintenance standpoint. This procedure was necessary since the main electrical equipment is high voltage and the air surrounding the plant carries an excessive amount of abrasive dust. A small make-up fan and electrolytic air filter is employed to keep the room under pressure. Air circulating fans are installed under each main fan motor. This circulating air is passed through cooling coils supplied with a special coolant, since sufficient water for cooling was not available.

One other brick control house was provided on the ground floor, adjacent to the storage bin building, in which other auxiliary control panels are installed.

There are approximately 60 motors installed in this plant, not including those operating the bucket crane. The bucket crane has a capacity of 20 tons and a hoisting speed of 70 fpm. This crane is equipped with two bridge motors connected in series, — four wheel drive and two trolley motors also connected in series with four wheel drive.

The 230 volt d-c feeder which supplies the cranes and adjustable speed motors is underground, — one 1,250,000 cir mil lead covered cable per side.

The control of the electrical equipment in this plant is unique in that all main operating motors are controlled at one central point, by the sintering machine operator from the firing floor, immediately adjacent to the sintering machine. This system of control includes sequence starting and stopping of equipment with emergency stop push buttons throughout the entire plant. A loud speaker is employed for giving instructions.

THIS is more than a war of mechanical monsters clashing in the night . . . more than a war of production.

It is a war for markets—*your* markets! The Axis wants your business—wants to destroy it for once and all.

With so much at stake, there is no doubt you will want to do everything you can to meet this Axis threat. Two ways are open: Speed production and BUY BONDS. The only answer to enemy tanks and planes is *more* American tanks and planes—and your regular, month-by-month purchases of Defense Bonds will help supply them. Buy now *and keep buying.*

HOW THE PAY-ROLL SAVINGS PLAN HELPS

When you install the Pay-Roll Savings Plan (approved by organized labor), you not only perform a service for your country but for your *employees.* Simple to install, the Plan provides for regular purchases of Defense Bonds through voluntary pay roll allotments.

Write for details *today!* Treasury Department, Section R, 709 Twelfth Street, NW., Washington, D. C.

U. S. SAVINGS

Bonds ★ Stamps

Republic Steel

OPERATES NEW BLAST FURNACE

..... the second blast furnace blown in under the DPC plan, this new unit occupies the site of an old furnace built in 1896 .....

by JOHN STOUFFER and MALCOLM MORGAN

Republic Steel Corporation

YOUNGSTOWN, OHIO

▲ THE first completely new blast furnace to be built in the Mahoning valley in a quarter of a century, was blown in with appropriate ceremonies by the Republic Steel Corporation at Youngstown, Ohio on October 12, 1942.

Lighted by Governor John R. Bricker of Ohio, in the presence of R. J. Wysor, president, R. L. Leventry, district manager, other Republic executives and many guests, the furnace represents the last word in blast furnace design. New from bedrock up, the furnace, it is predicted, will take its place among the largest producers.

Interesting to steel men and students alike, is the fact that this new furnace is located practically on the same site as the old Republic No. 1 hand-charged furnace which was built in 1896, and which was still in operation during the first World War. A giant in its time, it is estimated that it would require four such furnaces to equal the production of its successor.

Preliminary engineering for the new furnace was started in May 1941, and on October 10th the same year, a contract by the Defense Plant Corporation was awarded Republic, which sublet the work to several sub-contractors. All engineering and design work, writing of specifications, etc., has been done by the engineering department in Youngstown.

The work of clearing the site was started on October 29, 1941, and was itself a job of major proportions. Twenty thousand tons of blast furnace flue dust stored on the site had to be moved. By November 11th enough of the site had been cleared to commence driving piles for the ore storage yard retaining walls, which also act as the foundation for carrying the tracks for the ore

John Stouffer, Chief Engineer (left) and Malcolm Morgan, Superintendent of Coke Plant and Blast Furnaces. Mr. Stouffer has been associated with the Iron and Steel Branch, WPB, in Washington since January 11.

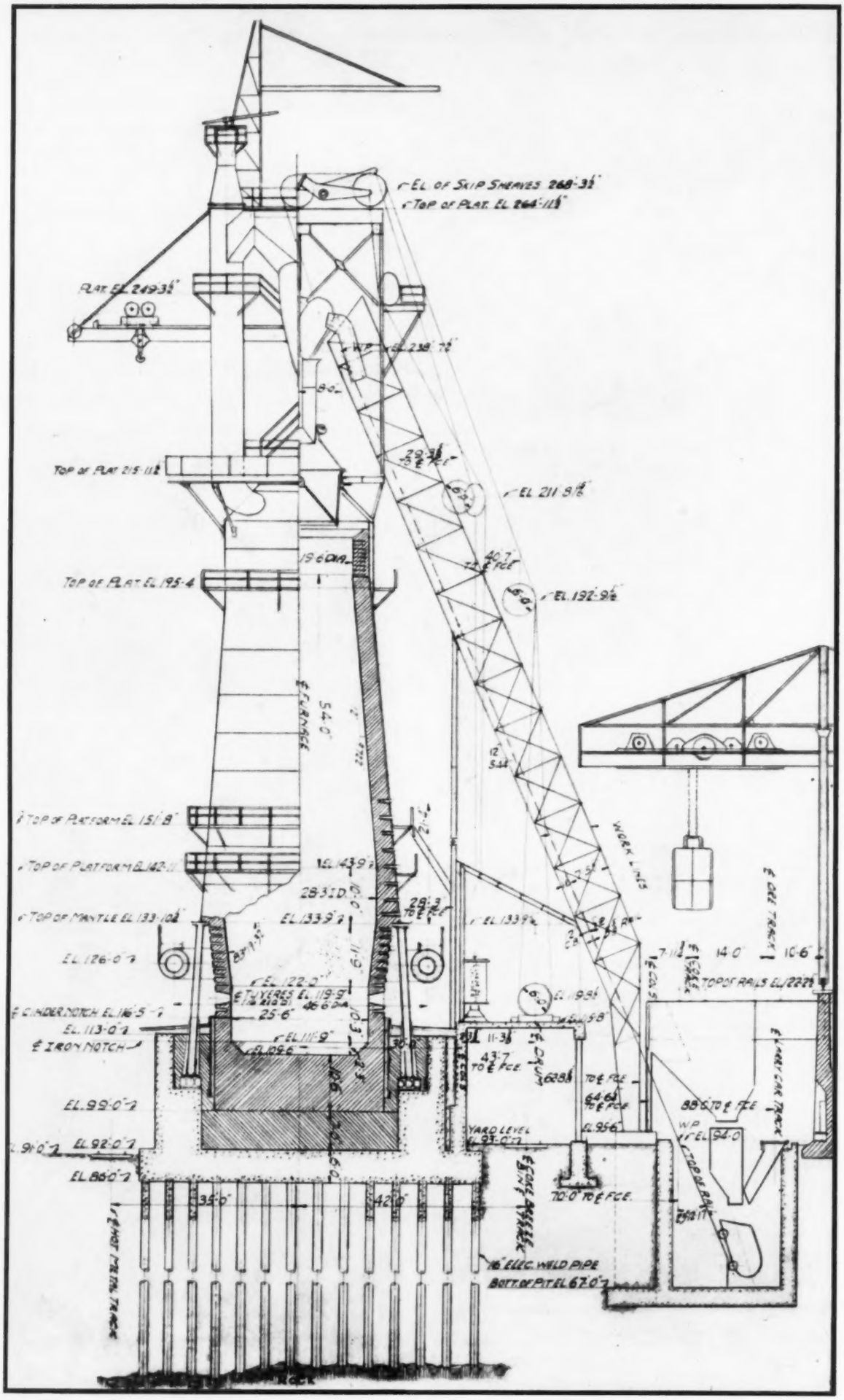


Figure 1 — Sectional view showing general arrangement of the new furnace.

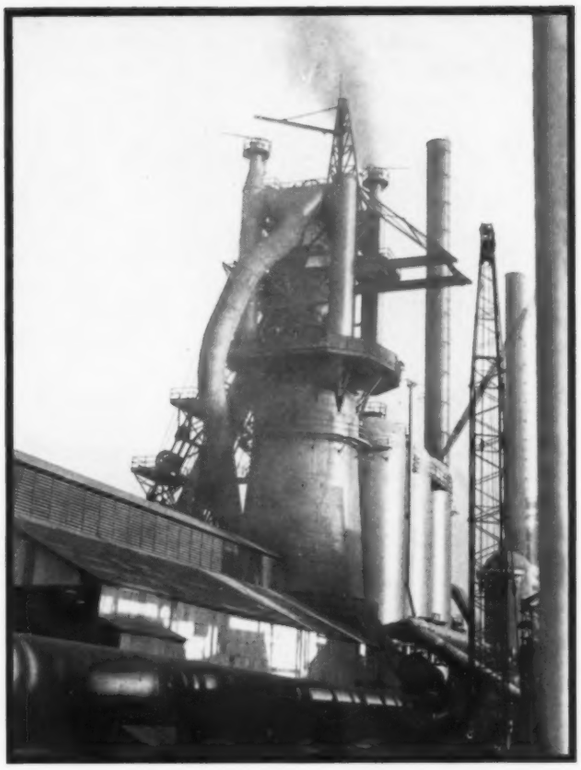


Figure 2 — With a working volume of 40,100 cu ft, the furnace has a nominal rating of 1100 tons per day.

yard gantry crane. The work of pile driving and concrete pouring for the ore yard continued through the winter of 1941-42.

By March, the design drawings for the furnace were in the hands of the fabricators, and excavation for the furnace foundation was started. The following is a brief resume covering the construction period, taken from the records.

On March 7th, pile driving for the furnace foundation was started, and during the next five weeks one hundred eighty-five 16 in. electric weld pipe piles, averaging sixty-three feet long, were driven to bedrock and filled with concrete.

Between March 7th and May 14th, all foundations for furnace, stoves and skip pit were completed, and erection of stoves, gas precipitators and stack was well advanced, and on May 14th, the base ring segments for blast furnace columns were set and leveled.

During the period between May 14th and May 26th, hearth cooling plates, hearth jacket, furnace columns and mantle were erected, and the first ring of the furnace shell was placed May 28th, and the shell up to the top cone was finished July 9th.

One of the construction features of this new furnace is that it is practically a completely welded job. All plate work on furnace, stoves and gas handling equipment is welded. Riveting is used only on skip bridge and structural details.

During welding operations many test coupons were cut and sent to the physical laboratory; this routine checking insured good consistent welding practice.

During May and June the remainder of the concrete for the ore storage yard walls and the cast house foundation was poured. Furnace lining from the hearth up to the mantle was started June 11th and finished July 15th, and from the mantle up to the abrasion plates was started July 15th and finished August 6th. Brickwork for the three stoves was started June 8th and finished August 24th.

Meanwhile during the summer, work had progressed on all the necessary appurtenances for the furnace, too many to mention in detail, but which may be classified under the following headings: stock house, furnace charging, gas handling, cast house, water piping and furnace controls.

Many miles of electric conduit and wiring have been installed to make the furnace operation as nearly automatic as possible, and all the safety features known to the industry have been incorporated in the design.

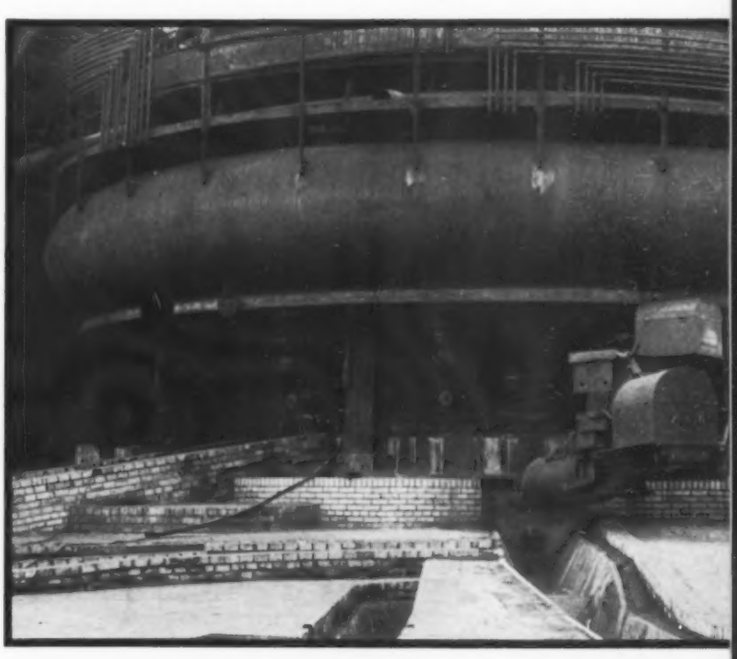
The following is a brief description of the furnace, lines of which are shown in Figure 1.

The furnace has a nominal capacity of 1100 net tons of iron per day. The hearth diameter is 25 ft 6 in., bosh diameter is 28 ft 3 in., stock line diameter is 19 ft 6 in. The bosh angle is 83 degrees-19 minutes-32 seconds, and the batter of the stack is .9722 in. in 12 in. The working volume, from tuyeres to stock line is 40,100 cu ft.

The hearth is 12 ft 6 in. high and the bosh 11 ft 9 in. high. Above the mantle there is a straight section 10 ft in height, followed by a 54 ft high battered inwall and a stock line section of 6 ft 8 in. height. Total brick work height is about 95 ft, with a total stack height of 107 ft 3 in.

Hearth and bosh jackets are of heavy welded steel construction, the hearth being cooled by cast iron water-cooled staves, extending down 15 ft from the

Figure 3 — The new furnace has a hearth diameter of 25 ft 6 in., and is blown through 16 tuyeres.



cinder notch level. Bosh cooling consists of eleven rows of standard copper coolers. Rows are spaced 18 in. apart, and there is a total of 316 coolers.

Above the mantle, cooling plates are carried up about 21 ft 4 in. and consist of eight rows of Dovel type copper coolers, spaced about three feet apart. There is a total of 192 coolers above the mantle.

The complete furnace lining required brick quantities as follows:

	Actual count	9 in equivalents
Foundation	258,000	258,000
Below mantle	94,450	292,436
Above mantle	215,012	414,000

The thickness of the bosh lining is 2 ft 7½ in., while the stack has a 3 ft 6 in. lining. The stock line is protected for a depth of 6 ft 8 in. by cast manganese steel abrasion plates bolted together and imbedded into the brickwork.

The furnace shell is of welded steel, resting on a heavy built up welded mantle, all supported on eight heavy rolled structural columns which rest on a heavy welded steel base ring.

The hearth of the furnace is built up of 10 ft 6 in. of hearth quality brick on top of seven feet of second quality ladle brick, all resting on a six foot thick concrete mat. The iron notch is placed 2 ft 3 in. above the hearth level and at an angle of 17½ degrees to the center-line of the cast house. The cinder notch is located 4 ft 8 in. above the iron notch, and at an angle of 45 degrees from the iron notch. This will allow for the accumulation of over 300 tons of metal between casts. Sixteen tuyeres 6½ x 15 in. are used, on a plane 3 ft 4 in. above the cinder notch.

The cast house is laid out to serve four ladle tracks, two on each side straddling the centerline of the furnace; the two inside tracks are dead end tracks, and the two outside are through tracks.

Nine 35 ton open top iron ladles can be spotted on the two tracks on the side furthest from the skip, and nine 320 cu ft slag ladles can be spotted on the two tracks on the skip side.

Furnace charging is accomplished by a double skip hoist using 200 cu ft skip buckets and operating at a speed of 600 fpm.

The skip hoist is controlled by an automatic charging control, and is electrically interlocked with the revolving distributor and the large and small bells to insure the proper cycle of operations, and is also equipped with overspeed, slack cable and travel limit protection, to provide safe operation at all times. The skip bridge

TABLE I
NO. 1 FURNACE BLOW-IN
OCTOBER 12, 1942 — 11:55 A. M.

Series	Charges	Coke per charge, lb	Limestone, lb			Furnace slag chg'd	Ore per charge, lb					O.H. slag	Ratio ore to coke	Tons pig chg'd	Slag volume per net ton iron	Mn in metal	Filling
			Actual	Theo.	Diff.		McCook	Cliff	Tilden	Saga	Total						
1	3	20,000	2,400	3,000	—600	4,000											
2	3	20,000	2,400	3,000	—600	3,800											
3	3	20,000	2,400	3,000	—600	3,600											
4	3	20,000	2,400	3,000	—600	3,600											
5	5	20,000	5,800	6,067		2,000	3,700	3,700	2,000	600	10,000		.50	2.48	3,310	.98	ooscccc
6	5	20,000	6,000			2,000	4,200	4,200	2,000	600	11,000		.55				
7	5	20,000	6,200			2,000	4,600	4,600	2,000	800	12,000		.60				
8	5	20,000	6,400	6,563		1,000	5,100	5,100	2,000	800	13,000		.65				
9	5	20,000	5,400	5,660		1,000	6,100	6,100	1,000	800	14,000		.70				
10	5	20,000	5,600	5,893		1,000	7,000	7,000	1,000	1,000	16,000		.80	4.25	1,760	1.00	
11	5	20,000	6,200			1,000	8,000	8,000	1,000	1,000	18,000		.90				
12	5	20,000	6,600			1,000	9,000	9,000	1,000	1,000	20,000		1.00				(Fce. full)
13	5	20,000	7,000			1,000	10,000	10,000	1,000	1,000	22,000		1.10				
14	5	20,000	7,400			1,000	10,900	10,900	1,000	1,200	24,000		1.20				
15	5	20,000	7,800	8,011		1,000	11,900	11,900	1,000	1,200	26,000		1.30	6.98	1,370	.82	
16	5	20,000	8,400			1,000	12,900	12,900	1,000	1,200	28,000		1.40				
17	5	20,000	8,800			1,000	13,800	13,800	1,000	1,400	30,000		1.50				
18	5	20,000	9,200				15,100	15,100	1,000	800	32,000	1,500	1.60				
19	5	20,000	9,600				16,100	16,100	1,000	800	34,000	1,500	1.70				
20	5	20,000	10,000	10,076			22,800	11,400	1,000	800	36,000	1,500	1.80	9.78	1,170	.95	ooscccc
21	5	20,000	10,300				23,600	11,800	1,000	1,100	37,500	1,400	1.88				
22	5	20,000	10,600				24,600	12,300	1,000	1,100	39,000	1,400	1.95				
23	5	20,000	10,900				25,600	12,800	1,000	1,100	40,500	1,400	2.02				
24	5	20,000	10,900				25,600	12,800	1,000	1,100	40,500	1,400	2.02				
25	5	20,000	10,900	10,941			25,600	12,800	1,000	1,100	40,500	1,400	2.02	11.00	1,110	.94	
26	5	20,000	10,900				25,600	12,800	1,000	1,100	40,500	1,400	2.02				
27	5	20,000	10,900				25,600	12,800	1,000	1,100	40,500	1,400	2.02				
28	5	20,000	10,900				25,600	12,800	1,000	1,100	40,500	1,400	2.02				

18 skips of coke of 5,000 lb each in hearth. No lime for flux. 4 ft of cord wood on coke, then filling above.
Wind, 20,000 cfm at start, 1,000 cfm added each hour to 30,000 cfm.

TABLE II

ANALYSIS OF BURDEN MATERIALS

Material	Fe	Phos	Mn	SiO_2	Al_2O_3	CaO—MgO
McCook	53.65	.048	.25	8.15	.69	.18
Cliff	52.10	.100	.26	7.30	2.41	.54
Tilden	38.90	.036	.10	41.30	.62	.42
Sagamore	37.16	.250	8.00	7.29	2.98	.80
Lake Erie stone	.66	.042	....	3.06	.39	51.24
Furnace coke	1.19	.027	....	5.55	3.31	.88
Open hearth slag	15.00	.050	7.00	15.00	3.60	37.82

TABLE III

ANALYSIS OF IRON AND SLAG FROM BLOW-IN

ANALYSIS OF FIRST 19 CASTS

Cast No.	Si	S	P	Mn
1	3.60	.024	.212	.94
2	4.40	.018		
3	3.44	.022	.200	1.26
4	2.59	.029		
5	2.70	.030	.214	1.22
6	2.25	.022		
7	2.50	.024	.200	1.26
8	2.46	.028		
9	2.47	.028	.200	1.24
10	2.69	.020		
11	3.02	.017	.188	1.30
12	2.69	.018		
13	1.70	.027	.192	1.20
14	1.98	.020		
15	1.95	.020	.200	1.22
16	1.35	.018		
17	1.77	.034	.178	1.02
18	1.85	.028		
19	1.44	.024	.184	1.00

AVERAGE ANALYSIS OF SLAG FROM FIRST 11 DAYS

Date	SiO_2	Al_2O_3	CaO	MgO	MnO	Sul	FeO
10-13-42	39.40	11.50	37.60	2.96	1.99	1.10	6.00
10-14-42	39.14	11.73	44.00	1.61	1.61	1.62	1.10
10-15-42	33.70	14.28	49.00	1.31	.25	2.32	.30
10-16-42	36.20	13.12	48.00	1.13	.37	1.86	.25
10-17-42	36.50	12.05	48.00	1.91	.40	1.88	.20
10-18-42	37.52	11.65	47.80	1.52	.49	1.64	.20
10-19-42	37.40	11.15	45.00	4.06	1.06	1.46	.60
10-20-42	39.04	11.88	40.40	6.38	1.10	1.50	.45
10-21-42	38.00	11.71	40.60	7.56	1.04	1.58	.30
10-22-42	38.80	11.61	41.60	6.03	.94	1.54	.25
10-23-42	38.06	11.36	41.00	7.41	1.03	1.58	.35

is supported independently of the furnace top on an "A" frame.

To insure good operation, a large space between the large and small bells has been provided, and it is possible to accumulate an 85,000 lb charge on the big bell before dumping. The big bell is 14 ft 5 in. in diameter, and there is an annular clearance of 2 ft 6½ in. when the bell is down. Bell actuating mechanism is supported by the top structure of the furnace, and is operated by cylinders located in the hoist house, and powered by the cold blast.

Ore is handled by a traveling bridge which also serves No. 5 furnace, and the ore yard has been extended 414 ft to provide additional ore storage. A new stock house of reinforced concrete with steel bins has been provided.

From the bins ore and stone are weighed in a new scale car, and the coke is measured by volume, electrodes determining both when the coke hopper is full and empty. A vibrating screen with ⅜ in. mesh removes the breeze, as the coke is fed to the measuring hopper.

There are four uptakes on the furnace, each 6 ft 1½ in. in diameter, and two downcomers, all unlined except at locations particularly subjected to abrasion. The downcomers are supported clear of the top platform, and have a uniform slope down to the dustcatcher.

The gas cleaning system consists of dustcatcher, a tower washer and two precipitators. Each precipitator is arranged in two sections, and by the operation of goggle valves, any of the four sections can be taken out of service for repairs or cleaning. Dust content of gas is reduced from 5 grains per cubic foot entering dustcatcher, to .0028 grains per cu ft leaving precipitators.

At present, a limited blast is furnished by existing turblo-blowers, but soon a new 90,000 cfm turboblower will go into operation, enabling the furnace to be operated up to capacity.

Three new 22 ft diameter stoves 113 ft high have been erected. They are the side combustion type, with hexagonal checkers with 178,000 sq ft of heating surface per stove. Stoves are equipped with burners and goggle valve in the gas line ahead of each burner. Automatic hot blast control is provided.

The furnace was started with a blast volume of 20,000 cu ft per minute, adding 1000 cfm each hour. Blast temperature was started at 1000 F

The first cinder was flushed 17 hours after lighting the furnace, and the first cast was made about 24 hours after lighting. Analysis of burden materials is shown in Table II and analysis of the early casts and slags are given in Table III.

At this time, the furnace is operating with a blast volume of 75,000 cfm, producing about 1225 net tons of basic iron per day, with a coke rate of 1715 lb per net ton of iron. Blast pressures average about 21 psi. Top temperature is about 250 F and top pressures about 35 in. H_2O.

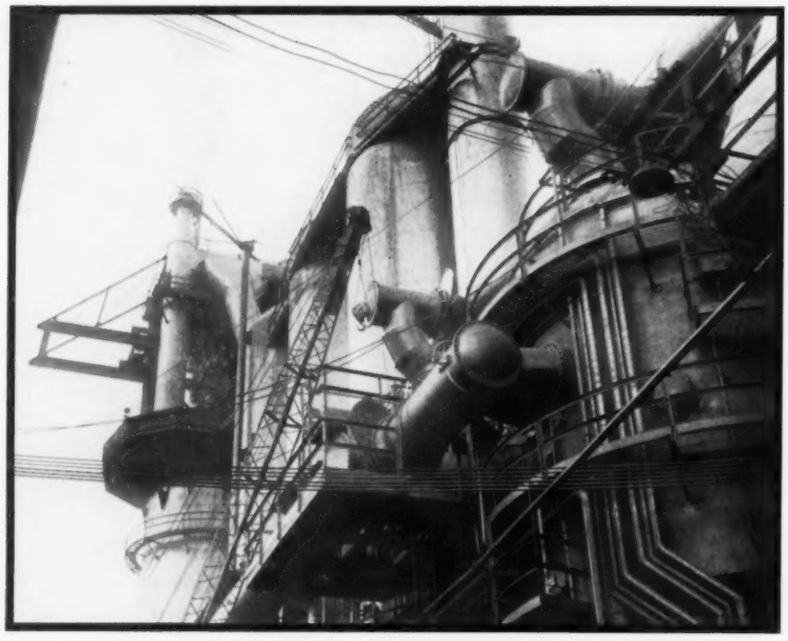


Figure 4 — Hexagonal checkers of special design afford 178,000 sq ft of heating surface in each of the 22 ft x 113 ft stoves.

Approximately 240 lb of flue dust is produced per net ton of iron. Gas analysis averages CO_2 14.7 per cent, CO 23.2 per cent, H_2+CH_4 3.2 per cent, and N_2 58.9 per cent. Slag voume is about 846 lb per net ton on basic iron.

Adjacent to the furnace, there is now being built a sintering plant. This plant will have a nominal capacity of 1000 tons per day, and will go into operation early in 1943.

This furnace is one of four authorized by the Defense Plant Corporation to be built by Republic Steel Corporation. The first furnace under the program was placed in operation on May 28, 1942 at Gadsden, Alabama. This is the second to be placed in blast, and will be followed by one in Chicago and another in Cleveland.

Of the seventeen furnaces being built by the Defense Plant Corporation, these are the first to be placed in operation.

Palm Oil-

ITS UTILIZATION IN THE STEEL INDUSTRY

. . . . . the last of three articles on "Conservation of Oils Essential to the Steel Industry" describes a method for reclaiming palm oil . . . . .

by R. P. DUNMIRE, Vice President

Buckeye Laboratories, Inc.

CLEVELAND, OHIO

▲ PALM OIL is obtained from the fleshy portion of the fruit of Elaeis Guineensis, a native of West Africa, and now extensively cultivated in the Dutch East Indies, Malaya, Sumatra and elsewhere. This palm has also been introduced into Ceylon, Indo-China, Brazil and British Guiana. It is essentially a light-demanding species and should be cultivated; it flourishes in soils rich in humus, but does not require a large amount of calcium, phosphates or potash. The most favorable natural condition for the cultivation of this palm are found in the Niger delta, Ivory Coast, lower Congo, the Seychalles, East Sumatra, Federated Malay States, Java, Borneo, Brazil and British Guiana. Normal height of the tree is about thirty feet, and fruit is borne usually after the fifth year. When mature, palms yield between 50 and 200 pounds of fruit, which is in bunches usually weighing between 10 and 35 pounds each.

The fruit is oval and pointed at the apex, between one and two inches long, and three-quarters of an inch to one inch in diameter. The average weight is about seven grams, and color may range from yellow through reddish brown to nearly black. The palm oil is obtained from the fleshy portion of the fruit, and this portion contains a considerable amount of fibrous material. The oil content of the fleshy portion varies between 30 and 70 per cent of the total weight.

In the center of the fruit is located the palm nut, the kernel of which yields the "palm kernel oil" of commerce. While normally the fruits contain one seed, some have been found with two or even three seeds.

A complete description of 18 varieties of this palm has been compiled by Baccori. The native names have also been correlated with this compilation. A good bibliography on the cultivation of the oil palm will be found in A. C. S. monograph No. 58 by Jamieson.

Formerly, all palm oil was obtained by crude and inefficient native methods, but more recently, modern equipment and methods have practically supplanted the earlier means, and a typical process is described below.

About 3000 pounds of palm fruit are introduced into a steam pressure digester provided with an agitator. The fruit is steamed with constant agitation, and transferred by an automatic conveyer to a centrifuge which contains a removable perforated metal basket of about 500 pounds capacity. Each charge is centrifuged for ten minutes, while steam is admitted to facilitate the separation and expulsion of the oil through the perforations in the basket. The oil is discharged through a pipe in the outer casting of the centrifuge into a tank from which it is pumped to the settling tank. The settled oil is then withdrawn to the storage tanks. After centrifuging, the basket is lifted by chains from the centrifuge and transported by an overhead runway to a hopper and the contents dumped. The hopper feeds a long inclined rotary drier which is heated by the fine gases from the boiler fires. Within 20 minutes, the dried fiber and nuts are discharged from the drier to an elevator which raises them to a rotary screen which separates the nuts, the latter passing to the nut crackers

Presented before A. I. S. E. CLEVELAND-YOUNGSTOWN DISTRICT SECTION.

which deliver the product to a screen for the separation of any uncracked nuts. The cracked nuts fall into a salt solution, the gravity of which is adjusted so that the shell fragments sink and the kernels float. The separated shells and kernels are collected and then centrifuged to remove the brine which is returned to the tank. The fiber and shell are burned under the boiler. The kernels are dried and bagged for export.

A plant with three full sized centrifuges can process more than twenty tons of fruit per day. Most of the operations are automatic. When sound fruits are used, the oil contains only a small amount of free fatty acids, usually under 5 per cent. A high yield of oil is obtained.

In some processes, hydraulic presses are used in conjunction with the centrifuges, or alone, and a higher yield of oil is claimed. The press cakes may be ground and extracted with solvents for further oil recovery.

Much work has been done on the engineering problems associated with the manufacture of palm oil, and the literature may be consulted for further details.

There has been considerable recent cultivation of the oil palm in Brazil, Peru and Manaos. The fruit is indistinguishable from the African type in appearance and structure, but the yield of oil is considerably lower, ranging from 20 to 45 per cent in the pulp, and approximately 35 per cent in the kernel.

An appreciable quantity of palm oil, after further refining to remove free fatty acids and subsequent bleaching, is used as an edible fat for cooking and in the manufacture of margarine.

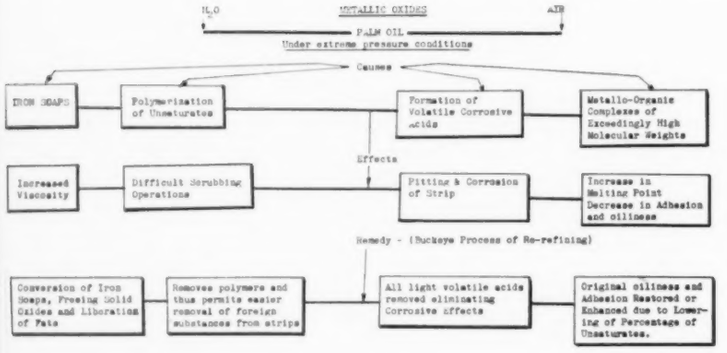
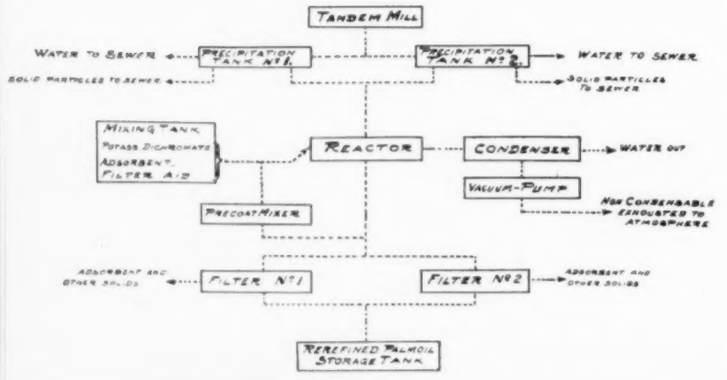

H_2O
METALLIC OXIDES
AIR
PALM OIL
Under extreme pressure conditions
Causes
IRON SOAPS
Polymerization of Unsaturates
Formation of Volatile Corrosive Acids
Metallo-Organic Complexes of Exceedingly High Molecular Weights
Effects
Increased Viscosity
Difficult Scrubbing Operations
Pitting & Corrosion of Strip
Increase in Melting Point Decrease in Adhesion and oiliness
Remedy - (Buckeye Process of Re-refining)
Conversion of Iron Soaps, Freeing Solid Oxides and Liberation of Fats
Removes polymers and thus permits easier removal of foreign substances from strips
All light volatile acids removed eliminating Corrosive effects
Original oiliness and Adhesion Restored or Enhanced due to Lowering of Percentage of Unsaturates.

Figure 1 — Chart showing the deterioration of palm oil when used on cold strip mills.

▲

Figure 2 — Chart showing flow diagram of palm oil treating system on cold reduction mill.



PROPERTIES AND CONSTITUTION

The ranges of the characteristics as obtained by reference to the literature are as follows:

Specific gravity at 15 C	0.9209-0.9250
Saponification number	195-210
Iodine number	46-60
Neutralization number	8-20
Refractive index at 40C (D)	1.4531-1.4580
Melting point, degrees C	25-50
Acetyl value	15-24
Unsaponifiable	Less than 0.5 per cent
Saturated acids	44-47 per cent
Unsaturated acids	48-54 per cent

Comparison of the constitution of the two main types of palm oil (Sumatra and Belgian Congo) show the following differences, taken as glycerides of the fatty acids:

Acids	Sumatra	Belgian Congo
Oliac	43.2	47.2
Linoleic	9.5	5.6
Myristic	0.6	0.5
Palmitic	44.0	40.6
Stearic	2.9	5.2
Lignoceric	0.1	0.1

Allen made an investigation of the unsaponifiable portion of palm oil, and by fractional crystallization obtained an orange-brown crystalline substance melting at 170-172 C, which is very susceptible to oxidation. The oxidation product obtained by exposure to the air has a strong odor of violets. The strongly characteristic violet odor of palm oil bleached with oxidizing agents is thus accounted for.

A study of analyses of the fatty acids from palm oils from all available sources gives the following limiting proportions:

	Per cent
Oleic acid	39 -49.5
Linoleic acid	5.6-10.7
Myristic acid	0.5- 2.5
Palmitic acid	30 -44
Stearic acid	2.9- 7.5

The variations are largely due to the differences inherent in the varieties of the palms from which the oils are derived. At ordinary temperatures the oil varies from a soft butter to the hardness of tallow. The higher the percentage of free fatty acids present, the harder the oil normally is. The color varies from pale yellow to deep orange; occasionally it is dark brown. Odor and taste are now usually fairly pleasant, in comparison with those of oils as formerly obtained by the more primitive methods of extraction.

Most palm oil can be bleached readily by heating to about 100 C and blowing air through it or by the use of other oxidizing agents. Oil refined by the caustic soda method for edible purposes is very stable in storage.

The flash point of palm oil is about 370 F and the fire point is in the region of 410 F.

There is no specific test for the identification of palm oil, as would be expected from consideration of its structure. The usual tests for suspected adulterants may however be applied. Large quantities of palm oil are used in soap making, and in the manufacture of oleo-margarine. It is also used as a fuel for internal combustion engines in tropical climates, where modifications are possible in design of semi-diesel and spark ignition engines. It is the utilization of palm oil in the tin plate industry and in the cold-rolling of steels, however, in which we are chiefly interested.

PALM OIL IN COLD ROLLING AND TIN PLATING

The writer's company recently made a very complete study of the use of palm oil in the cold rolling of steel strip; the results of this work may be of interest. The set-up in the cold rolling of steel strip is as follows:

The palm oil supply tanks and catch basins are located in the basement directly below the tandem mills. The palm oil to be supplied to the mills is usually heated to a temperature of not less than 165 F and then pumped up to the mills through steam heated pipes to assure fluidity of the oil at the feed points at the stands.

The sheet being rolled comes from the hot strip mill, through the pickling operation and is then run through a bath of palm oil. The primary purpose of this treatment is to inhibit corrosion, while a secondary consideration would be that of assuring a complete film of palm oil at the point of entry at the cold strip mills.

After the preparation outlined above, the sheet is passed through the tandem mill, and palm oil is fed to the strip at the stands. Excess palm oil, together with the cooling water from the mill drops into gutters, and is led to the catch basins in the basement. The palm oil is permitted to settle out of the mixture, and rises to the surface as a sludge containing a considerable amount of water, varying between 30 and 60 per cent of the total mass, as shown by tests conducted in our laboratory.

After cold rolling, the strip is passed through a scrubber to remove adhering oil or other impurities, and from the scrubber to an annealing furnace. From here it goes to the temper-pass mill and then to the shearing line, where it is trimmed and sheared to size. The sheared plates then pass through the white pickler, are washed, and then are transferred to the tinning machines where the sheets are fluxed, tinned, washed and polished. In the hot dip tinning process, the sheet is first passed through a bath of flux, and then through the molten tin, the surface of which is covered with palm oil. It will be seen that the palm oil is subjected constantly to a very high temperature, in the neighborhood of 470 F, and the rate of deterioration must consequently be very great. After polishing, the tin-plate is ready for inspection and sorting.

DETERIORATION OF PALM OIL IN SERVICE

In our preliminary study of the deterioration of palm oil in service, it was thought that the only causes of this occurrence would be (a) emulsion with water from the cooling system at the cold-rolling mill (b) the incidence of solid particles or aggregated like carbonaceous

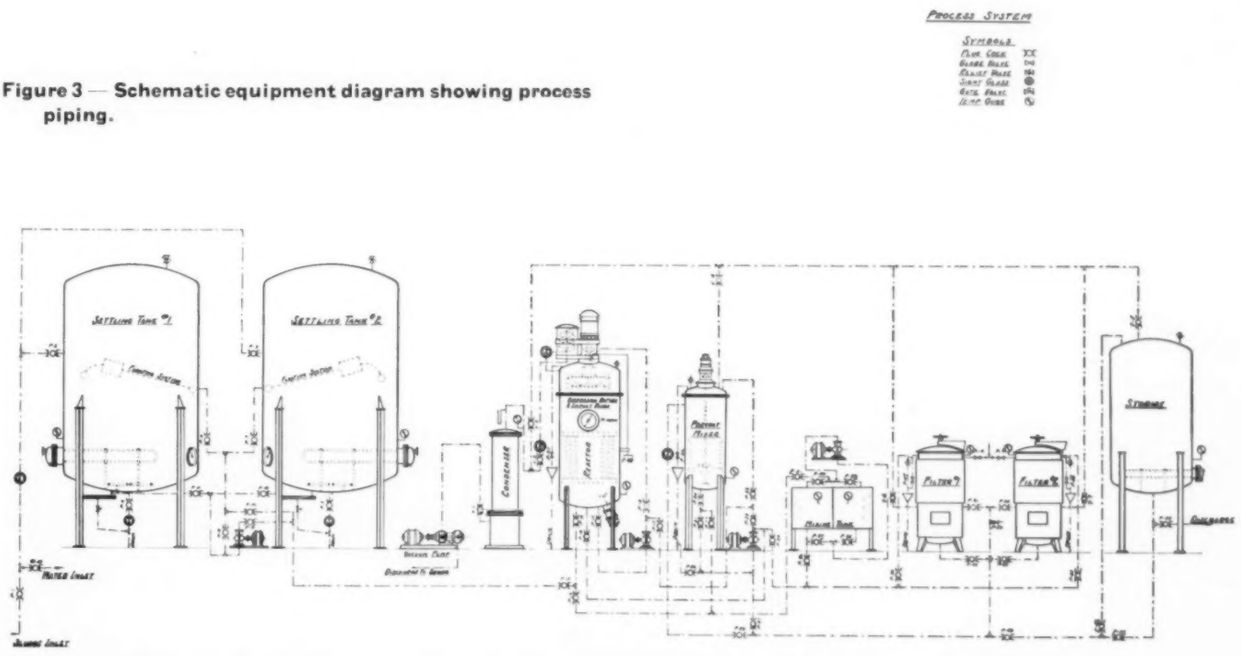


Figure 3 — Schematic equipment diagram showing process piping.

matter and iron oxide or iron scale, and (c) the presence of iron soaps of the palm oil fatty acids which would be soluble in the remainder of the palm oil, and would cause no adverse effects if permitted to remain in that solution.

Analyses of the ash obtained by the incineration of previously dried palm oil from the rolling mills early showed that the problem was not so simple.

The mean value of the determination of the ash from a considerable number of samples of contaminated but previously dehydrated palm oil was 2.93 per cent. When an extraction of the solid matter from the same palm oil was made by means of organic solvent (carbon tetrachloride) it was found that the residue amounted to 3.41 per cent of the total weight of sample taken. When this extracted material was incinerated it was found that the inorganic contact, consisting of metallic oxides and silica, was only 0.37 per cent. If we subtract this value from that of the total ash we find that 2.56 per cent was attributable to the metal oxides resulting from the combustion of oil-soluble metallic derivatives of the palm oil glycerides or fatty acids. If the assumption be made that metallic oxides had reacted with the palm oil to form simple metallic soaps, we would have the equivalent of 26 per cent of iron soaps dissolved in palm oil. In the light of the remainder of the experimental evidence the above hypothesis is completely untenable.

Since the palm oil consists of more than 50 per cent of unsaturated fatty acid esters the presence of metallic oxides promotes a reaction which causes scission in the high molecular weight glycerides and the formation of appreciable quantities of chemically active low molecular weight acids such as acetic, formic and propionic. These acids are quite corrosive in nature and will react with a high proportion of iron oxide to form the ferric salts of these acids. We may represent a typical reaction of this group as follows:

Equation 1 —

$$2\ CH_3\ (CH_2)\ 7\ CH{=}CH\ (CH_2)\ 7\ COOH + Met\ O_2 + 2\ H_2O$$

$$Met - 2\ CH_3\ COOH + 2\ CH_3\ (CH_2)\ 14\ COOH$$

(Oleic acid plus metallic oxide plus water forms metal plus acetic acid plus myristic acid)

Equation 2 —

$$Met\ (OH)_2 + 2\ CH_3\ COOH \rightarrow \begin{matrix} CH_3\ COO \\ CH_3\ COO \end{matrix} \!\!> Met - 2\ H_2O.$$

(Metal hydroxide plus acetic acid forms metal acetate plus water.)

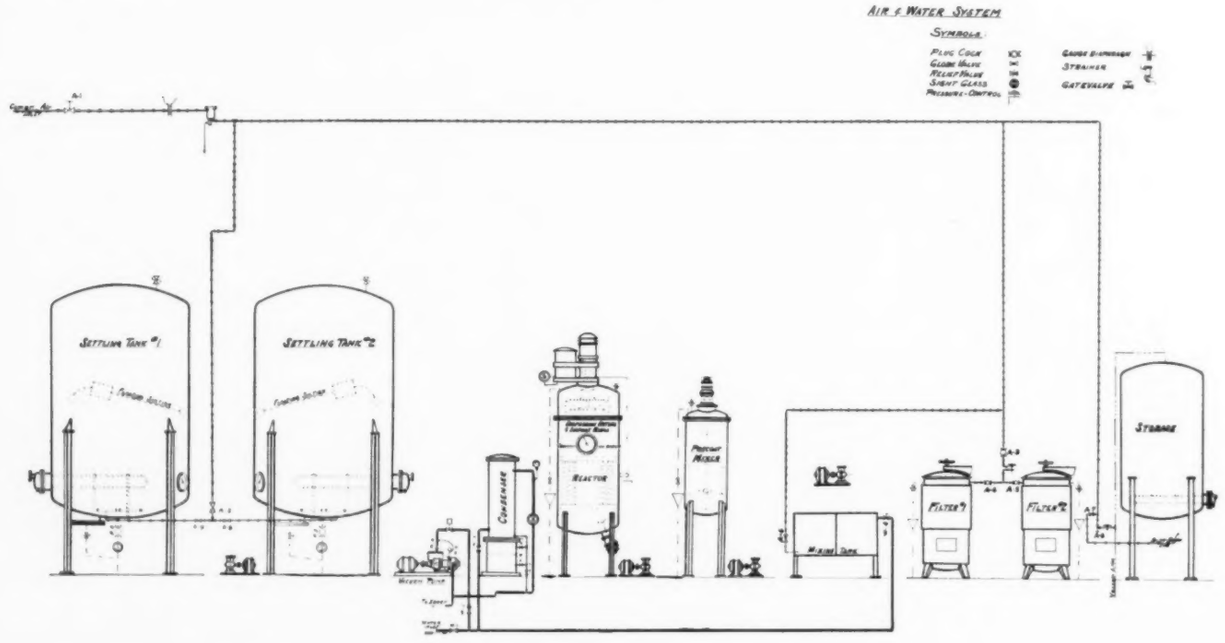
Much of the iron found in the ash must originally be present in the form of the salts of these more volatile acids.

Another consequence of the presence of some metallic oxide is the reduction of ferric oxide to the ferrous form. This ferrous oxide will act on the palm oil in a manner quite different from the ferric oxide and is responsible for the formation of polymeric compounds which are of much higher molecular weight than the original palm oil, and these polymers will greatly increase the viscosity of the remaining oil. This reaction may be typified as leading to the formation of compounds of the type represented by the formula below:

$$\left(\begin{matrix} CH_3\ (CH_2)7\ CH & & CH\ (CH_2)7\ COO\ R \\ & \diagdown\ \diagup & \\ & Fe & \\ & \diagup\ \diagdown & \\ CH_3\ (CH_2)7\ CH & & CH\ (CH_2)7\ COO\ R \end{matrix} \right) X$$

At the olefin bonds of two molecules of unsaturated

Figure 4 — Schematic equipment diagram showing air and water piping.



acids, the ferric iron enters a chelate bond and supplies the last valence required to form the chelate ring which is the nucleus of the high molecular weight polymeric bodies.

Analyses have shown that the neutralization number of the used palm oil is approximately equal to that of the new palm oil and the iodine numbers and saponification numbers are materially decreased. Consideration of the formula for the iron complex given above shows that these conditions must exist in order to identify the presence of the complex. If the compound can be broken down to remove the iron as a solid oxide or hydroxide we would have regeneration of the two molecules of unsaturated ester or acid. The neutralization number would be unchanged but the iodine value would be increased due to the regeneration of the olefin bond. Figure 1 is a graphic illustration of the deterioration of palm oil.

RECLAMATION OF USED PALM OIL

We have attempted to show in the foregoing that palm oil, which in itself is a mixture of several component fatty acids and of their glycerides, is subject to a series of changes resulting in the formation of a variety of compounds which may range from low molecular weight fatty acids and their salts to polymeric substances which increase the viscosity of the total mass to an observable degree. When the quantity of palm oil utilized daily in the steel industry is considered, the economic value of an efficient process for reclamation becomes apparent.

In January, 1941, a quantity of palm oil sludge was re-refined by preconditioning, dehydration and subsequent treatment with an adsorbent followed by filtration. The re-refined palm oil was still quite dark in color and when melted was found to be slightly more viscous than the original palm oil. Test runs were made at the cold strip mill in Yorkville, Ohio, using this refined palm oil, both on tin plate gauges and on heavier gauges, and no difficulties were noted during the rolling operation. The strip was sent to the scrubber and to the subsequent operations in the usual manner, and a close check was maintained of the condition of the strip at each step. The strip tinned successfully without aberration or necessity for departure from the customary schedule, and the final inspection subsequent to tinning showed no objectionable features.

Analysis of the re-refined palm oil showed that some differences existed between the product and new palm oil, but that the characteristics of the treated oil were oil were very much closer to those of new oil than they were to those of dehydrated palm oil sludge.

A great deal of subsequent work has been done to obtain a product of better quality at a reasonable cost. Considerable progress has been made and our most recent work has shown that most of the very high molecular weight viscous polymers are removed as well as volatile corrosive acids, and to give greatly decreased values for ash. This means that we are now able to remove much more of the iron present than was accomplished in the preliminary tests. Analyses are appended of new palm oil, of untreated used palm oil which has been dehydrated, and of used palm oil which has been subjected to the new treatment.

	New palm oil	Used untreated palm oil dehydrated	Palm oil treated with new process
Neutralization number	22.6	23.1	23.6
Saponification number	197	145	187
Iodine value	52	36	46
Ash	.11	.78	.15

PALM OIL REFINING SYSTEM

Briefly, our palm oil treating system consists of two large steam-heated settling tanks, a reactor, a condenser, a vacuum pump, a pre-coat mixer, two filters, a two-compartment slurry mixing tank and a re-refined palm oil storage tank, as illustrated by the block flow diagram, Figure 2, an examination of which shows that the flow of oil from the skimming pit beneath the tandem mill may be directed to either one of two precipitation or settling tanks from which the major portion of the water and solid particles may be drained off to the sewer after which the semi-dehydrated sludge is transmitted to a reactor wherein the sludge is thoroughly dehydrated, under relatively high vacuum, after which the sludge is treated by means of a reactant such as potassium dichromate and then further treated with an activated adsorbent material. After the proper reaction and adsorption process has been completed, the solid materials, including the adsorbent, are removed from the oil by means of one of two filters.

The schematic process diagram, Figure 3, illustrates the various process piping required to accomplish the desired results. Figure 4 shows the schematic arrange ment of the air and water piping and Figure 5 shows the steam piping.

The palm oil sludge which contains approximately 40 to 60 per cent water in a highly emulsified state is pumped from the settling or skimming pit, beneath the tandem mill roll stands to either settling tank No. 1 or No. 2 as a starting point of the process employed. The general description and function of each of the units used in the processing follows in the approximate order in which they are employed.

Settling tanks — The settling tanks into which the palm oil sludge is pumped are each equipped with a steam-heated tube bundle to heat the palm oil-water sludge, and raise it to a temperature suitable to accomplish the maximum degree of separation of the palm oil from the water as well as the solid materials which precipitate readily.

A drain valve and a suitable sight glass or look box are connected to the bottom of the tank so the water and heavy solid contaminants which have separated from the palm oil may be drained into the sewer frequently. A perforated pipe is arranged in the bottom of each settling tank so the palm oil sludge may be aerated by means of introducing compressed air which, of course,

increases the buoyancy of the exceedingly small globules of palm oil which rise rapidly to the upper surface.

These tanks are provided with a sight glass fitted with a cleaner so the separated water level and condition of the sludge may be observed.

A suction arm fitted with floats is connected to the tank shell by means of a swing joint which permits the collection nozzle on the end of the suction arm to be slightly submerged beneath the surface of the separated palm oil and above the layer of separated water and precipitated solid contaminants. This enables the sludge pump to remove the palm oil for re-refining at the point at which the maximum degree of separation has been accomplished. The time required for this separation usually is approximately 72 hours but is dependent on the initial condition of the palm oil-water emulsion. After thorough separation has been accomplished, the sludge is pumped into the reactor for chemical and further physical treatment.

Sludge pump — The sludge pump is of the turbine type and is equipped with stainless steel impeller, shaft and liners which may be removed and replaced easily without dismantling the piping. This pump being of the turbine type is not readily injured by handling small solid particles of an abrasive nature.

The piping of the sludge pump is so arranged that the separated palm oil may be removed from either precipitation tank and delivered to the reactor. An additional piping arrangement is incorporated whereby the entire contents of either precipitation tank may be transferred from one to the other so the tanks may be emptied periodically for inspection and cleaning. Such an inspection should be made at least once every sixty days.

Reactor — The reactor, in which all the purification or re-refining activities take place, is connected through a condenser to a vacuum pump which removes the vaporized constituents from the palm oil being treated and exhausts the non-condensible vapors to the atmosphere while the vapors which have been condensed and collected in the condenser are drained off to the sewer.

The operations occurring in the reactor are as follows:

(a) Complete drying or dehydration of the palm oil sludge.
(b) Thorough contacting of the sludge with the solution of preconditioning catalyst.
(c) Thorough contacting the dehydrated oil with an activated, or other suitable adsorbent material.
(d) Continuous removal of the gases by sweeping with steam.
(e) Separation of the particles of liquid components from the vapor components by means of a dephlegmator or separator.

The reactor is constructed of heavy gauge plate and is equipped with a very efficient type motor-operated impeller for thoroughly mixing the reactant with the palm oil being treated and is located on the bottom of the tank so as to be readily accessible for maintenance purposes. It also performs the additional function of mixing or contacting the adsorbent material for adsorbing various types of impurities from the palm oil. The process of adsorption is, of course, dependent on the temperature, speed and time of contacting. The impeller also performs the additional function of imparting sufficient turbulence to the liquid being heated to affect efficient heat transfer from the steam heating coils.

The reactor is equipped with a steam heated removable tube bundle of sufficient capacity and heating surface to heat the palm oil being treated at a low heat density per square foot of surface thereby preventing injury to the oil by overheating. The steam flow to the tube bundle is controlled by means of a steam regulating valve actuated by a temperature bulb located in the inside of the reactor.

The reactor is equipped with two steam heated annular rings and baffles over which the oil is passed by

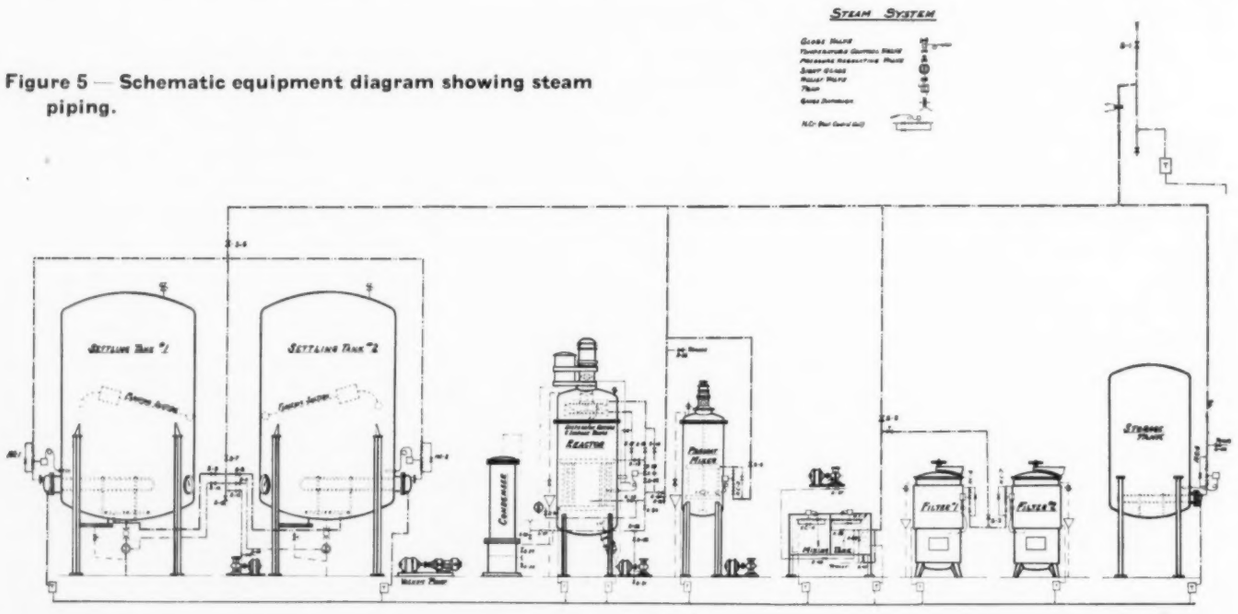


Figure 5 — Schematic equipment diagram showing steam piping.

the circulation pump. The flow of the oil onto the upper baffles is controlled by means of a sleeve valve which is located in the top of the reactor.

A separator or dephlegmator is attached directly to the top of the tank and is so arranged that the collected globules of liquid are drained or refluxed back into the reactor while the separated gases are passed on through to the condenser vacuum pump. The main body of the reactor is equipped with a 12 inch sight glass fitted with a cleaner or wiper on its interior so the operation of the reactor and the condition of the oil being treated may be readily observed by the operator during treatment.

The reactor operates in conjunction with a circulating pump which is connected from the bottom of the reactor to the sleeve valve in the top section above the baffles for recirculating the palm oil over the heated baffles in the top section of the reactor tank.

In addition to the above, a condenser is connected directly to the gas separator or dephlegmator by means of suitable piping and a sight glass interposed in the line so the vapors coming over from the gas separator may be readily observed. The sight glass is equipped with a steam cleaner and is illuminated so this operation may be followed at all times. The condenser is of the tube bundle type and is equipped with valves to control the passage of the gases and efficiently condense water and light oil vapors coming from the reactor.

The condenser is fitted with a receiving chamber having two compartments to receive the condensate from the condenser. The two compartments are so connected that the condensate may be drained off at intervals without shutting down the equipment. The surface of the condenser is adequate to insure most efficient operation.

A vacuum pump of the water-seal type is connected to the condenser for removing the non-condensible vapors which pass through the pump and are exhausted to the atmosphere. The vacuum pump has no moving parts in metal to metal contact. Consequently an exceedingly long life may be expected from it. The internals are readily removable and replaceable without disturbing any of the piping. Such a pump handles relatively large slugs of an noncondensed liquid which might accidentally pass through the pump without injury to it.

Operation of the reactor — The reactor, after having been filled with the palm oil to be treated and charged with the required quantity of Fuller's earth or reactant material, operates as follows: Steam is turned on both the main heating tube bundle and the top annular steam heated rings and the agitator started. The circulating pump which causes the oil to flow over the steam heated baffles is started as well as the vacuum pump and cooling water for both the vacuum pump and condenser is turned on and the palm oil flow regulated to the circulation pump by means of a throttling valve and a sleeve in the top of the reactor.

Immediately this operation has been established steam is admitted into the bottom of the reactor through a perforated pipe so as to act as a sweeping agent and accelerate the removal of the gases liberated by heating the palm oil mixture.

With these adjustments all made, the reactor operates as follows: The major portion of the latent heat

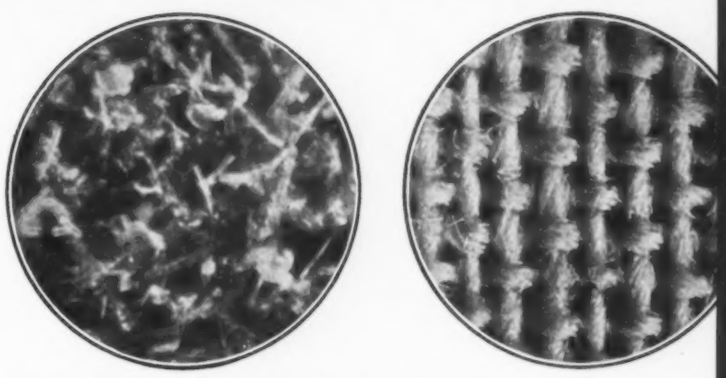


Figure 6 — Enlarged views showing fineness of celite filter-aid channels (left) in comparison with closely woven filter cloth (right).

of vaporization is supplied by the main tube bundle heater while being contacted with the adsorbent material or reactant by means of the high speed mixer thereby insuring thorough contacting of the liquid with the adsorbent as well as effective heat transfer from the heating tube bundle and the liquid is then being circulated by the circulation pump through the sleeve valve and onto the surface of the steam heated baffles over which it flows in the form of a fine film.

These annular rings supply the balance of the heat required to instantaneously flash off such gases as are liberated by the forementioned action. After passing over the baffles the oil is drained back to the main body of the liquid. This entire operation is carried out under a vacuum of at least 20 in. so the break down of the palm oil-water emulsion and the removal of the released vapors are readily accomplished and are considerably accelerated by the steam which has been introduced as a flushing agent.

The light volatile acids of low molecular weight as well as such contaminants as torch oil together with the water, are swept out of the reactor into the gas separator and may be observed through the illuminated sight glass which is interposed between the gas separator tank and the top of the reactor.

It is well to be reminded at this point that this process is made especially efficient by accomplishing effective fractional distillation at low temperatures without excessive frothing or foaming and at temperatures which do not overheat the palm oil and which would cause considerable damage to it.

It is well to call the reader's attention to the fact that the normal boiling point of water at atmospheric pressure is 212 F whereas the boiling point of water at 20 in. vacuum is approximately 160 F and at 26 in. of mercury, approximately 124 F and the normal operating vacuum applied to this equipment ranges from 20 to 29.5 in. of mercury. The reactor is also equipped with a chain operated relief valve so as to prevent the building up of excessive pressure within the reactor.

Suitable pressure gauges are installed both on the reactor tank and in the feed line to the sleeve valve.

After practically all moisture and light volatile contaminants have been removed by the initial operation

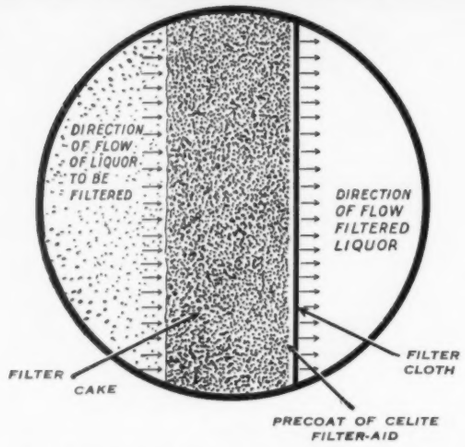

DIRECTION OF FLOW OF LIQUOR TO BE FILTERED
DIRECTION OF FLOW FILTERED LIQUOR
FILTER CAKE
FILTER CLOTH
PRECOAT OF CELITE FILTER-AID

Figure 7 — An enlarged sketch illustrating the manner in which a filter-aid prevents the passage of finely divided impurities through the filter cloth.

The Filter Cake — All the impurities suspended in the liquid being filtered are accumulated here. The cake is kept open by the filter-aid which is mixed with the liquid to be filtered.

The Precoat — A thin film of filter-aid is deposited on the filter cloths by precoating. This thin film is open to the passage of clear liquids but is positively impervious to all solid impurities. It serves to keep the main filter cake containing the impurities from coming in direct contact with the filter cloth.

The Filter Cloth — Its sole function is to support the precoat and the filter cake. Slimes and gums do not reach it to clog the meshes and slow down filtration, or penetrate the cloth and cause cloudy filtrates.

of the reactor, the reactant material or preconditioning agent is prepared in the mixing tank.

The mixing tank — The mixing tank which is provided for this process facilitates the mixing of the various material used in the treatment of the palm oil and their transfer to either the reactor or the precoat mixer. The mixing tank consists of a two-compartment steam heated tank, each compartment being so piped and valved direct to a motor-operated sludge pump which also acts as the apparatus for mixing thoroughly the Fuller's earth or adsorbent material into a slurry with palm oil so it may be pumped by the sludge pump into the reactor.

The sludge pump is so constructed that it will readily handle exceedingly large quantities of abrasive materials without excessive wear and is equipped with specially hardened plates and removable liners. The side of the mixing tank in which the palm oil adsorbent slurry is mixed, is equipped with steam heated coils, temperature indicator and temperature controlled steam valves for regulating the supply of steam to the heating coil as well as an air ejector to aid in accomplishing thorough agitation.

The other side of the mixing tank is used for mixing the reacted material with a sufficient quantity of water to make up a saturated solution of the reactant which is thoroughly agitated until the solution is complete, by means of a steam agitator which operates as an auxiliary to the steam heated coils which are equipped with a temperature control for controlling the steam and a suitable indicating gauge.

A mixture of the preconditioning catalyst, usually ($K_2Cr_2O_7$) and sufficient water to form a solution is made up in the steam heated mixing tank and pumped into the reactor, and thoroughly contacted with the palm oil by means of a high speed mixer impeller, during which time the reactor is held under a relatively high vacuum so that the proper reaction takes place, that is, the metallo-organic compounds are converted to the metallic oxides with liberation of the fats. These precipitated oxides, of course, are infinitely small with respect to particle size and in fact are of colloidal dimensions and although unfilterable while in that state, are readily adsorbed by means of a suitable adsorbent material.

After thoroughly contacting the oil and catalyst in the reactor and after it has reached the desired degree of dehydration, a mixture compound of preconditioned oil from the reactor and a suitable adsorbent is made into the form of a heavy slurry in the mixing tank, and is then transferred again to the reactor where the process of adsorption takes place.

In speaking of the adsorption process as applied to this equipment, it might be well to mention the fact that the rate and degree of adsorption is unquestionably controlled by the time, temperature and speed of mixing or contacting the adsorbent with the molecules of the oil being treated.

Generally relatively little is known of the process of adsorption; however, it is described generally by Gurwitch and Moore in their work on Technology of Petroleum and briefly is as follows:

"The decolorizing properties of bone charcoal, Fuller's earth, silica-gel, and many other finely porous substances have been known for some decades, and has been met with continually increasing application in the petroleum industry. These substances have become most indispensable in the preparation of many petroleum products. The physical-chemical process named adsorption which underlies the action of finely porous substances has been exhaustively studied by many investigators, particularly during the last few years."

In the adsorption process, the action appears to be as follows:

When the adsorbent comes into contact with a solution it attracts molecules of the dissolved substances as well as the solvent to its surface. As a result of this attraction, films consisting of condensed molecules are formed about the particles of adsorbent, and the dimensions of these films are determined by the radius of action of the adsorbent.

The proportion of the molecules of the dissolved substance and those of the solvent in this film are determined, in the first place, by the proportion of the two kinds of molecules in the solution, and secondly by the force with which one and the other are attracted by the adsorbent. When, therefore, one and the same adsorbent acts upon equally concentrated solutions of various substances in the same solvent, the one which is most strongly attracted by the adsorbent is adsorbed to a greater degree.

If, on the other hand, we take equally concentrated solutions of one and the same substance in various solvents, the substance is most strongly adsorbed from the solvent, the attractive power of which for the given adsorbent is the least. Thus, in adsorption there may be said to be a contention between the molecules of the dissolved substance and those of the solvent as both

strive to attain the greatest possible concentration at the surface of the adsorbent.

What has already been said on the general character of the force of the physical-chemical attraction, renders it possible to predict many of the phenomena of adsorption and so to control these processes to a certain degree; and in this consists the advantage of the mechanical view of adsorption as described.

We will now consider the behaviour of various constituents of petroleum when treated with Fuller's earth from this point of view. The greatest interest centers on the adsorption of resinous and similar substances which give their color to petroleum products, and in general are to be regarded as detrimental and undesirable constituents. As we know, these substances are acid-containing, partially unsaturated, and belong to those constituents of petroleum with the highest molecular weights. On the basis of what has been said above, we may, therefore, expect that petroleum resins and asphalts will be adsorbed in a particularly high degree, and this has been confirmed by experiment and in practice.

All that has been said above refers also to the adsorption of naphthenic acids, which are very readily adsorbable owing to the presence of the carboxyl group. Here also the acids of high molecular weight are more readily adsorbed than those of low molecular weight.

The behaviour of the nitrogen and sulphur compounds of petroleum as regards adsorption is as yet little investigated, but it is known that they are readily adsorbed.

The method adopted for contacting the Fuller's earth is of a continuous nature. The great advantage of this method over that of the filtration method lies in the much greater rapidity of the process, which is promoted by the fact that the finest ground earth made may be used when operating by this method. With the finer powdered Fuller's earth the adsorption, and especially that of coloring substances, proceeds much more rapidly than by any other method.

The application of Fuller's earth, especially a clay which has been activated, to the treatment of vegetable oils such as palm oil, has been proven to be quite effective, as the results obtained with this equipment indicate.

During all the various steps of processing in the reactor, the removal of moisture is being accomplished at all times without excessive foaming by applying steam as a sweeping agent.

After the aforementioned treating operation has been accomplished in the reactor, the palm oil is then ready for filtering out the adsorbent material with its adsorbed contaminants and other mechanical or solid impurities by means of the filters which have been prepared for this operation by being precoated with a filter aid.

Precoat mixer — The precoat mixer which is used for thoroughly mixing and maintaining the precoat material in suspension in the palm oil which is used for precoating the filters prior to the filtering operation and for maintaining the filter aid in suspension during the precoat operation, is constructed of heavy gauge plate and has mounted thereon a 3 hp motor for driving the impeller.

The capacity of the precoat mixer is such as to effect a suitable balance between the filter and the quantity of material used for precoating the filters and is equipped with a relief valve for venting the tank during certain operations as well as acting as a safety measure if undue pressure should be built up in the mixer. It is also fitted with a steam coil for heating and maintaining the temperature of the oil being filtered in the neighborhood of 250 to 300 F.

The steam coil in turn is controlled by means of a thermally operated steam control valve. The mixer is also equipped with the necessary sight glasses for observing the liquid height and pressure gauge as well as a vent which is manually operated. The precoat mixer, after the operation of precoating the filters, also acts as a surge tank for equalizing the flow of treated palm oil from the turbine mixer to the filters.

After the precoating operation the palm oil mixture is fed continuously from the reactor so that immediately upon the reactor being emptied, filtration may be proceeded with and the reactor recharged with a fresh batch of treated palm oil from the reactor.

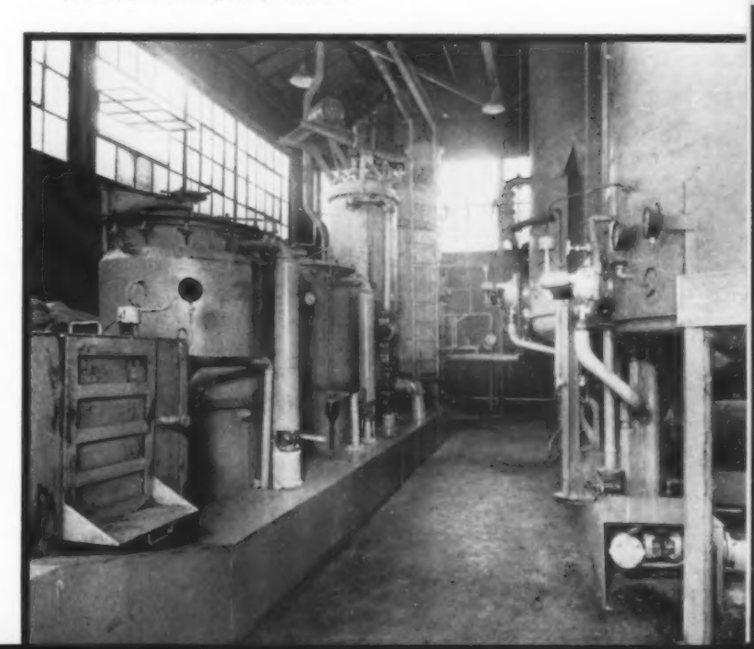
Filter feed pump — A filter feed pump of the turbine type with removable stainless steel internals is used for feeding both material from the precoat mixer to the filter as well as circulating precoat material to either or both of the filters to establish a precoat on the filter leaves. The rate of feed from the precoat mixer to the filters under either the operation of precoating the filters or the actual filtration of the treated palm oil is controlled by a flow control known as Fulscope which controls an air-operated feed valve which is connected so as to operate as a by-pass on the filter feed pump. The Fulscope may be adjusted so as to maintain any given pressure on the filters. This arrangement avoids excess packing of the filter cake on the filter leaves.

Filters — Filtration is accomplished by means of two filters either one of which may be operated while the other is being cleaned.

The filters consist of several leaves on which are mounted glass filter cloths and which are connected to a discharge manifold near the bottom of the cylindrical filter tank.

To accomplish the degree of filtration required with a

Figures 8 — View of a typical installation for the complete re-refining of palm oil.



material such as palm oil, it is necessary to use a filter of precoated type. Filtration is usually accomplished by forcing a liquid under pressure through a cloth or screen. Theoretically the liquid should pass through the opening of the filter cloth and the impurities should remain upon the cloth but what actually happens in a great many cases is that the finer suspended solids pass with the liquid through the comparatively coarse openings in the filter cloth. The larger particles remain behind upon the cloth to clog the openings, smear the cloth and slow down or entirely stop the flow through the filter leaves. Such difficulties are emphasized by what may be termed clarification filtration, where the particles to be removed are slimy or colloidal in size. Palm oil presents this type of filtration problem.

The finely divided suspended matter cannot be completely removed nor can definite clarification be affected economically unless a filter aid is added before the oil passes through the filter. Figure 6 illustrates the use of an appropriate filter aid for the formation of a precoat on the filter cloths with respect to the method used in obtaining a clarity. A diagrammatic cross section through the filter cake illustrates the formation of the filter cake upon the filter cloth (see Figure 7).

A small quantity of appropriate filter aid of the celite type added to the liquid being filtered assures the formation of an open cake on the filter leaves and greatly increases the rate of flow. In addition to the use of the celite as a filter aid, it is necessary to form a precoat on the filter leaves prior to the beginning of filtration so as to protect the screens and facilitate the removal of the cake when the filtration cycle is complete.

In normal operation, a previously filtered quantity of palm oil is mixed with celite filter aid, thus forming a slurry in the heated mixing tank until it is in thorough suspension. Usually approximately 10 lb of filter aid per 100 sq ft of filter area are used for this precoat charge. An additional quantity of filtered palm oil is transferred to the precoat mixer so that with the prepared volume of slurry added, the total volume is approximately 125 to 150 per cent of the total volumetric capacity of the filter pump and pipe lines.

The precoat suspension is then pumped through the filter at a low pressure depositing a thin film of filter aid over the surface of the screen. The palm oil is returned through the filter discharge to the precoat mixture tank, the agitation being continued and circulation maintained until the palm oil shows no evidence of suspended solids. Filtration can now be started.

The proper temperature for economic filtration is maintained by means of a tubular heater in the precoat mixer, and by means of steam jackets on the filters.

While preparing the precoat, a predetermined quantity of celite filter aid is added to the main batch of palm oil in the reactor and thoroughly dispersed by the high speed mixer or agitators.

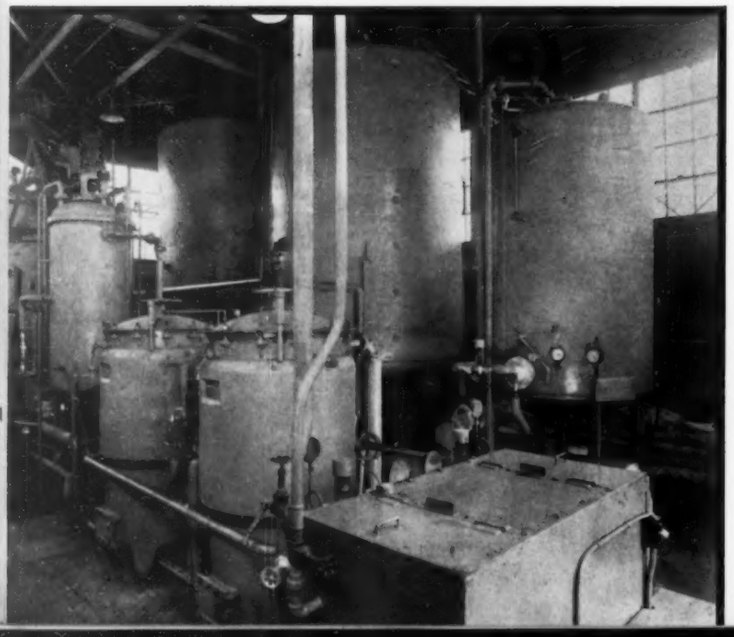
When the precoating of the filters has been completed, the flow from the filter is directed to the re-refined palm oil storage, or receiving tank, and the treated palm oil from the reactor is pumped into the precoat mixer, until the reactor is empty. After this the reactor is recharged for the beginning of a new treating cycle, and the filtration continued until the precoat mixer is empty.

The filters and filter cakes on the filter leaves are blown dry with compressed air. The cake is then removed from the filter screens by removing the entire set of leaves as a unit from the filter shell and removing the entire coating on the leaves and returning the filter element to the shell for further operations.

As the filtering operation continues the filtered oil is conducted to the re-refined oil storage tank.

Re-refined palm oil storage tank — The storage or receiving tank for the re-refined palm oil is of 2000 gallon capacity and is equipped with a steam heated tube bundle for maintaining the palm oil at a temperature which permits easy handling. The tube bundle is equipped with a suitable thermally operated steam controlled valve and the receiving tank with a suitable temperature indicator, pressure gauge and relief valve. An air supply is also connected to the tank for removing the re-refined palm oil from the same, thereby eliminating the use of a pump. The usual temperature maintained in the storage tank is approximately 180 F. The re-refined palm oil is then returned to the tandem mill for further use. Figures 8 and 9 show a typical installation for the complete re-refining of palm oil.

Figure 9 — Palm oil treated in systems such as shown here may be re-used on all types of cold mills without experiencing production difficulties.



BIBLIOGRAPHY

Army Ordnance — November, December, 1941.

The Waverly Handbook — Published by the Symon Company, 1003 Investment Building, Pittsburgh, Pennsylvania.

Panorama of Lubrication — Shell Petroleum Corporation, St. Louis, Missouri.

General Discussion on Lubrication — Volume 1 and 2 — *The Institution of Mechanical Engineers* — Published by American Society of Mechanical Engineers, New York, New York.

Maintenance of Lubricating Oils — R. P. Dunmire, Buckeye Laboratories, Incorporated — July 1936 issue, *Iron and Steel Engineer*.

Effects of Gases in Transformer Oils — C. J. Rodman and A. H. Maude, American Electro Chemical Society.

American Petroleum Refining — H. S. Bell, C.E., D. Van Nostrand Company, New York, New York.

Petroleum and Its Products — Wm. A. Gruse, PhD., Mellon Institute of Chemical Research, McGraw-Hill Book Company.

Chemical Refining of Petroleum — Vladimor Kalichevsky, Research Laboratory, Socony-Vacuum Corporation; Bert Allen Stagner, Mellon Institute of Industrial Research; Chemical Catalog Company, New York City.

Proceedings of Edison Electrical Institute — 1929 to 1935.

Petroleum Technology — Scientific Principles — Dr. Gurwitsch and Harold Moore, D. Van Nostrand Company, New York City.

Lubrication of Anti-Friction Bearings — James I. Clower, *Iron Age*, October 3, 1935.

Engineering Bulletin No. T-39 — Technical Division, Standard Oil Company of Indiana.

The Chemical Mechanism of Lubrication — Wm. F. Parrish and Leon Cammen, A. S. M. E. Paper, December 5, 1932.

Again, THANKS *Industry*

for our 50th and most important year

IN JANUARY, 1942, we gratefully thanked Industry for its half-century of confidence in Hyatt. That message heralded the beginning of the 50th year of Hyatt Roller Bearings.

Since then . . . with our country in peril of its life . . . American industry has thrilled the Allied world with startling feats of production.

Like soldiers on attack, men of the design boards and production lines swung to the job of pouring out the machines that will win this mechanized war.

Industry called on Hyatt for vital bearing assignments in planes, tanks, ships, guns . . . and in the machines that build them.

Creating bearings for such vital service was more than a responsibility. It was a privilege. It was a command!

Without lost motion the whole productive effort of Hyatt became a single aim . . . to rush the most devastating fighting power possible into the hands of our fighters and their allies.

Under the impetus of our fight for freedom, Hyatt precision production has swelled tremendously. This took place despite the many necessary changes made in designs and sizes, tools and methods . . . all having been accomplished without losing a stride in the race against time.

Working with you . . . for America . . . has given us the chance to be extra proud of our fiftieth year, just completed. It was by far Hyatt's most important year . . . in manufacturing achievement and in contribution to the great cause.

Therefore, for giving us a golden opportunity in our golden year, again we say THANKS, INDUSTRY.

Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

1892 ☆ 1942
Fifty Fifty... FOR 50 YEARS
INDUSTRY AND HYATT PARTNERS IN MECHANICAL PROGRESS

HYATT ROLLER BEARINGS

Synthetic Scrap by DIRECT REDUCTION

. . . . . it is claimed that direct reduction of iron ore by the Harman process will produce a synthetic scrap at costs equal or lower than the blast furnace-converter combination . . . . .

by E. S. HARMAN, VICE PRESIDENT

Loftus Engineering Corporation

PITTSBURGH, PENNSYLVANIA

▲ THE importance of finding substitutes for steel scrap is known to all, and need not be dwelt upon here. The production of synthetic scrap from blast furnace metal is available in some plants, but is limited by blast furnace capacity available for the purpose. New blast furnace capacity being built is limited by the availability of critical materials such as turbo blowers. Coke supply is another limiting factor on the expansion of blast furnace capacity. It is apparent that the new blast furnace capacity under construction cannot be used to meet both the demand for iron as well as the demand for scrap. This situation has revived interest in the direct reduction of ore.

There are many different methods of reducing ore to metallic iron which fall under the category of direct reduction. The products of these processes are classed as sponge iron, granular iron, briquetts and cast iron. Through carelessness or lack of clear conception all of these products have been given the general designation of sponge iron.

Generally speaking sponge iron is the product obtained through low temperature reduction, whereby the iron becomes plastic but is not melted. The gangue of the ore is fluxed and squeezed out of the iron.

Granular iron is usually produced at temperatures below that at which the iron becomes plastic and separation of the gangue and iron obtained magnetically. Granular iron has also been produced by sintering the reduced iron involving temperatures high enough to cause plasticity, then quenching in water, crushing and magnetically separating the iron from the gangue. The objection to the latter method is that the silica in the ore becomes physically combined with the iron and cannot be magnetically separated.

Briquetting is resorted to for fine ores as well as granular iron. Granular iron is briquetted for two purposes: (a) to prevent oxidation in melting and (b) to increase its mass so that it will not float when charged into a bath of molten metal. Briquetting of ores is usually confined to the more pure concentrates of fine ores.

The principle objection to these processes has been low rates of production, and consequent high cost per ton. The principle cause of low production is the low temperatures obtained from the reducing flame, which is required for supporting the reaction between carbon and iron oxide. The requirement for iron ore reduction is a reducing atmosphere. A reducing atmosphere represents incomplete combustion and consequently low temperature. The requirement for melting the reduced iron is a high temperature, which is most conveniently obtained by complete combustion, involving an oxidizing atmosphere. Hence, the two requirements — that of a reducing atmosphere and its consequent low temperature, and that of a high temperature and its consequent oxidizing atmosphere oppose each other. The result has been that most direct reduction processes are confined to reduction of the ore, producing a granular, or nodulized metallic which is magnetically separated from the gangue of the ore.

An exception to this is the Bassett process which melts the iron, thus producing a cast iron. A description

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 22-24, 1942

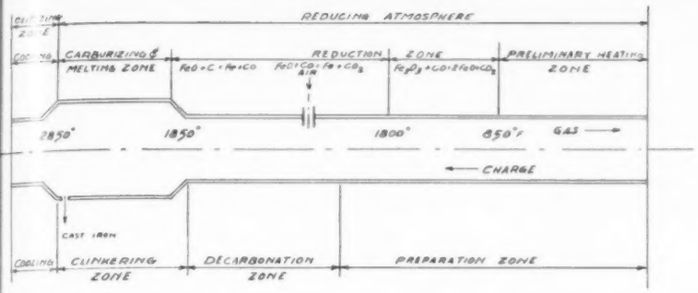


Figure 1 — Progressive reactions in kiln producing iron and portland cement.

of this process was published in the July, 1936 issue of Rocks Products magazine. Bassett utilizes a 9 ft x 140 ft rotary kiln, the melting end of which is of a larger diameter to form a melting pot from which iron is tapped. This is illustrated in Figure 1. The kiln is charged with finely ground iron ore, limestone and coal. The amount of stone charged is such that the lime silica ratio complies with the analysis of cement clinker. Cement clinker has a melting temperature of approximately 3000 F or over, whereas the iron containing 4.3 per cent carbon melts at about 2160 F. The kiln is fired with a powdered coal burner, developing temperatures of 2850 F in the melting chamber. The gangue of the ore and the limestone are clinkered at temperatures approximately 2700 F, and is discharged at the lower end of the kiln. The differential in melting temperatures permits the iron to be molten and the slag clinkered. The reactions for the ore are shown above the kiln on Figure 1, while stages of transition in the stone are shown below the kiln.

The analysis of the iron is given as:

Silicon	.10 to .15
Carbon	4 to 4.5
Sulphur	Trace
Phosphorous	.065
Manganese	Approx. .4

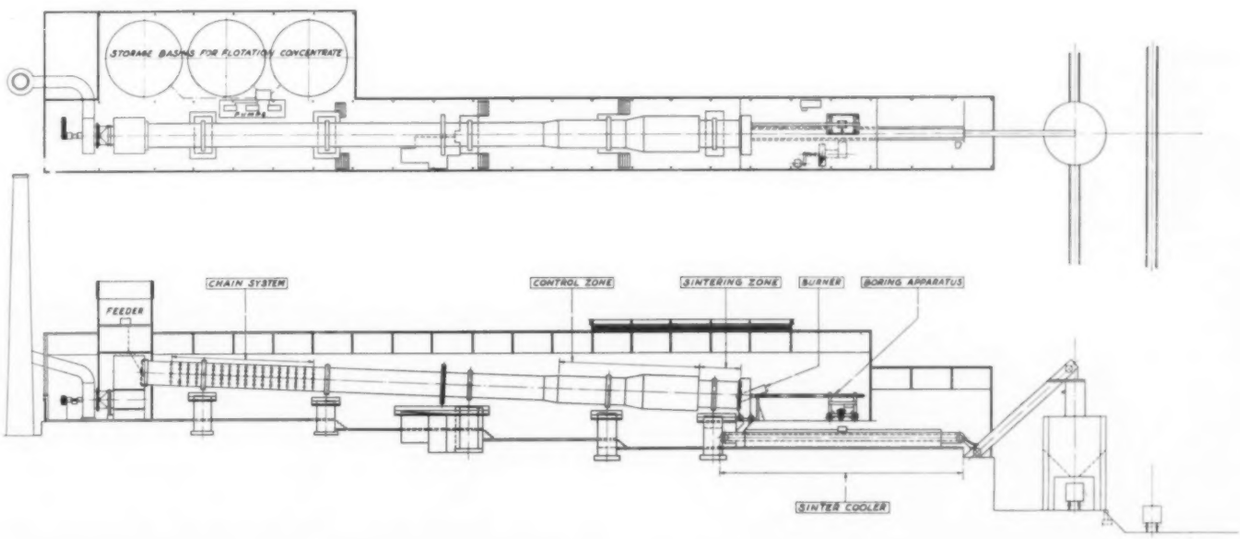
The silicon content is very low. This is due to the fact that silica does not reduce to silicon, except in the presence of excess carbon, which is not present in this case. The manganese in the iron remains the same as the manganese content in the ore. It is interesting to note that the sulphur is practically eliminated. This may be partially attributed to the high limestone charge, which is about twice as great as that of the blast furnace, and also to the fact that the back end of the kiln acts as an ore roaster. The charge that iron produced by direct reduction is high in sulphur is true only in some cases.

It is well to note that Bassett carries a flame sufficiently oxidizing to obtain a fairly high temperature, although a reducing atmosphere is shown on the sketch, and the article states that the burners were adjusted to give a reducing flame. Bassett and others state that a CO/CO_2 ratio of 65/35 at the burner, is sufficiently reducing for the purpose. The rate of production of the plant is given as 65 tons of iron and 65 tons of clinker per day.

The iron analysis as given above is desirable from the standpoint of low sulphur and low silicon. The objection to the process is low production and the consequent high cost.

The facilities for economic production do not seem to be present in the development as presented by Bassett, in that, it would not be feasible to secure the high melting rates, required for commercial production. It would appear that separation of the melting functions, from that of the reduction functions of the process, might be advantageous, and to this end, it is well to

Figure 2 — Rotary kilns of this type can be built for sintering ore in capacities up to 1200 tons per day.



study a recent development on ore sintering in a rotary kiln shown Figure 2. Kilns of this type can be built for capacities up to 1200 tons of sinter per day.

S. G. Thyrre presented a paper before the Eastern States Blast Furnace and Coke Oven Association outlining the progress made in recent years on ore sintering in rotary kilns. Figure 3 shows the ringing experienced when using the plain walled kiln. The new development was directed toward eliminating this objectionable ringing which was responsible for failures in rotary kiln sintering. Figure A of Figure 4 shows the temperature gradient of the material and gases obtained in a straight walled kiln in which ringing is experienced. Figure B of Figure 4 shows the temperature gradient of the material and of the gases which is obtained in a kiln of the F. L. Smidth design. It will be noted that the diameter of the kiln just before the discharge has been enlarged to 14 ft which has the effect of retarding the rate of heating, holding the temperature below that at which ringing occurs. The material is then brought rapidly up to approximately 2300 F temperature in the narrower straightwalled section in the discharge end. The flame temperature in this section is high enough to melt any accumulation adhering to the wall and what little ringing does occur is confined to the extreme end of the kiln and is removed by the insertion of a water cooled boring bar shown in Figure 5.

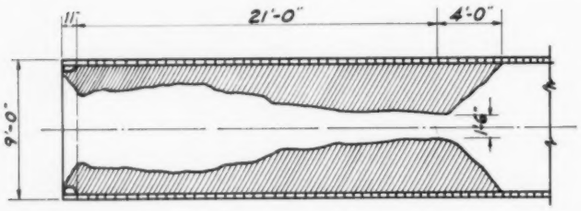


Figure 3 — Cross-section showing contour of ring built up in 9 ft x 175 ft rotary kiln.

▲

Figure 4 — Chart showing temperature gradient of material and gases in (A) straight walled kiln and in (B) Smidth design.

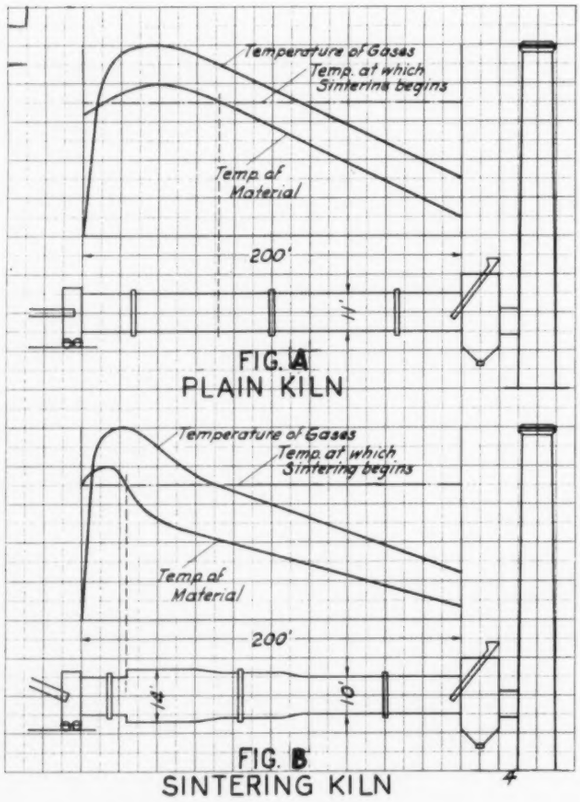


Figure 6 shows a sintering kiln discharging into a vertical melting furnace. The material charged into the sintering kiln, which now becomes a reduction kiln, consists of finely crushed ore and limestone, with sufficient carbon such as coke breeze to affect the metallurgical reaction required for reduction. The mixture is heated to 2300 F in the reduction kiln and discharged into the melting kiln. The amount of coke charged with the material is about 500 lb per ton of iron. Additional carbon is added to the material as it leaves the reduction kiln. This is for the purpose of adding carbon to the iron in the bath as well as to reduce oxidation loss in iron. The carbon content of the product may be varied at will, subject, of course, to practical limitations in melting temperatures. Hence the product will be a synthetic scrap in the true sense of the word.

The melting furnace is fired with an oxidizing flame with an air preheat of 1800 F. In order to meet the requirements for a reducing atmosphere for the reduction kiln, the oxidizing gases from the melting kiln are converted, or reformed into reducing gases by the injection of a reagent such as carbon or hydrogen as they leave the melting furnace. With powdered coal as fuel, incandescent carbon is added to the gases to convert the CO_2 to CO. This is an endothermic reaction absorbing heat but as it takes place after the gases leave the melting chamber it does not affect hearth temperature, an advantage not offered in the Bassett plant.

It might be well at this point to illustrate the difference between oxidizing and reducing gases.

Figure 7 shows curves of equilibrium between hydrogen, water vapor and iron, and also between carbon monoxide, carbon dioxide and iron. The ordinate of this chart represents the percentage of carbon monoxide with respect to carbon dioxide.

The area above the line marked FeO-Fe represents the condition of temperature and gas composition under which metallic iron will exist unchanged in contact with the gas, or that in which iron oxide will be reduced to metallic iron by the action of the gas. The line marked Fe_3O_4-FeO indicates the range of compositions which will produce ferrous oxide in the area above the line, and ferric oxide in the area below the line. The total area above the FeO-Fe curves summarizes all of the gas compositions and temperatures under which no oxidation occurs. The area below the FeO-Fe curve and above the Fe_3O_4-FeO summarizes the gas compositions and temperatures which will produce ferrous oxides.

The area underneath the Fe_3O_4-FeO curve indicates all conditions which will produce ferric oxide.

In the curve of equilibrium for hydrogen, it will be noted that the ratio of hydrogen to water vapor decreases as the temperature increases, which means that a lower percentage of free hydrogen is necessary to render water vapor reducing in action at the high temperature than at the low temperature, whereas with carbon monoxide the reverse is true.

The conversion of the oxidizing gases to reducing gases may be expressed by the simple equations shown on the upper right hand portion Figure 7. As previously stated, to render water vapor non-oxidizing it is best to add hydrogen in the form of natural or coke oven gas while for carbon dioxide, we may add either carbon monoxide or pulverized carbon. The selection of which of the two should be added is illustrated by equations 5 and 6, Figure 7. If solid carbon is added, two-thirds of the total fuel is burned to CO_2 and the maximum amount of high temperature heat is released in the melting chamber. This thermal reaction is patterned after that of the blast furnace wherein the wind blown through the tuyeres unites with the carbon to form, first CO_2 furnishing the high temperature heat and then the CO_2 unites with additional coke to form CO.

In equation 6 only one-third of the total carbon is burned to CO_2 while two-thirds of it is burned to CO resulting in relatively low flame temperatures. This type of combustion is characteristic of the usual direct reduction processes producing sponge iron and granular iron. The temperature of the gases entering the reduction kiln as well as the total heat supplied remains the same in both cases.

Referring to Figure 6, the melting furnace is fired with essentially a CO_2 flame supplying the necessary high temperature heat for melting. The CO_2 gases are subsequently converted to CO by the injection of incandescent carbon at the throat of the uptake. This conversion is necessary in order to supply the reducing atmosphere required for supporting the reactions in the kiln. As the quantity of heat thus supplied is insufficient for the thermal requirements of the kiln, an additional burner firing a CO flame is applied through the kiln housing.

The analysis of the metal will be similar to bessemer blown metal with the exception of manganese and nitrogen, as nitrogen is not absorbed in the metal, nor is the manganese oxidized out of the metal. The sulphur will be low by virtue of the facts previously explained. With Lake Superior ores, sulphur in blast furnace iron originates from the coke. The quantity of coke in direct contact with the iron in the direct reduction plant is only one-third of that in blast furnace practice, which is another reason why the sulphur will be low. While the carbon content of the product may be varied at will, practical consideration of temperatures, place a restriction on maintaining an extremely low carbon. Figure 8 illustrates the familiar iron carbon diagram from which it may be seen that, at the eutectic of 4.3 carbon, the melting point is 2150 F whereas an iron with 1½ per cent carbon, has a melting point of 2550 F. The average temperature of cast from a blast furnace is 2550 F, which is 400 F above melting. This process, with tapping temperature between 2900 and 3000 F, common in open hearth practice, allows the same margin, 400 degrees, above melting if the carbon content is 1½ per cent.

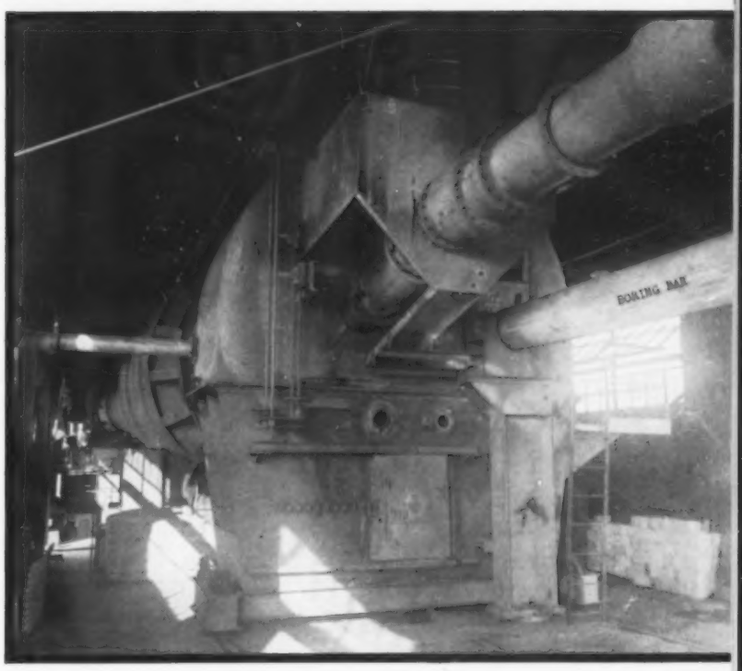


Figure 5 — View showing boring bar entering door in hood of sintering kiln.

The production of synthetic scrap by the direct reduction process is offered, not as a substitute for, but as a supplement to, blast furnaces. The plant as described is in reality, a horizontal blast furnace, so constructed as to permit the production of a low carbon charging stock, or pig scrap. Comparative cost of synthetic scrap production by this process and the blast furnace-bessemer process are shown in Table I. These costs are only relative as they naturally will vary with the cost of materials.

On a coke basis, the fuel required amounts to 1650 pounds of coke per ton of iron which in turn is equivalent to approximately 2648 pounds of coal per ton of iron. In general, the cost of fuel for the direct reduction process for any one given location, is less than the cost of fuel for the blast furnace.

The above outline covers the historical and preliminary studies on direct reduction which led to the development of the new process. A detailed description of this process follows.

Capacity — Using a 50 per cent Fe ore the plant will have a capacity of 400 tons of super-grade molten charging stock per day. The figures contained in this discussion are based on this production.

Preparation of materials — Ore, limestone and carbon in the form of coal, coke or oil coke in the proportions of 40:8:5 are dried, crushed to about ⅛ in., intimately mixed and fed into a rotary ore sintering kiln.

Reduction — The materials are advanced through the rotary kiln, heated by a reducing atmosphere, in the presence of which, reduction of the iron occurs through reaction with the solid carbon in the charge. The entire aggregate is subsequently impregnated with additional

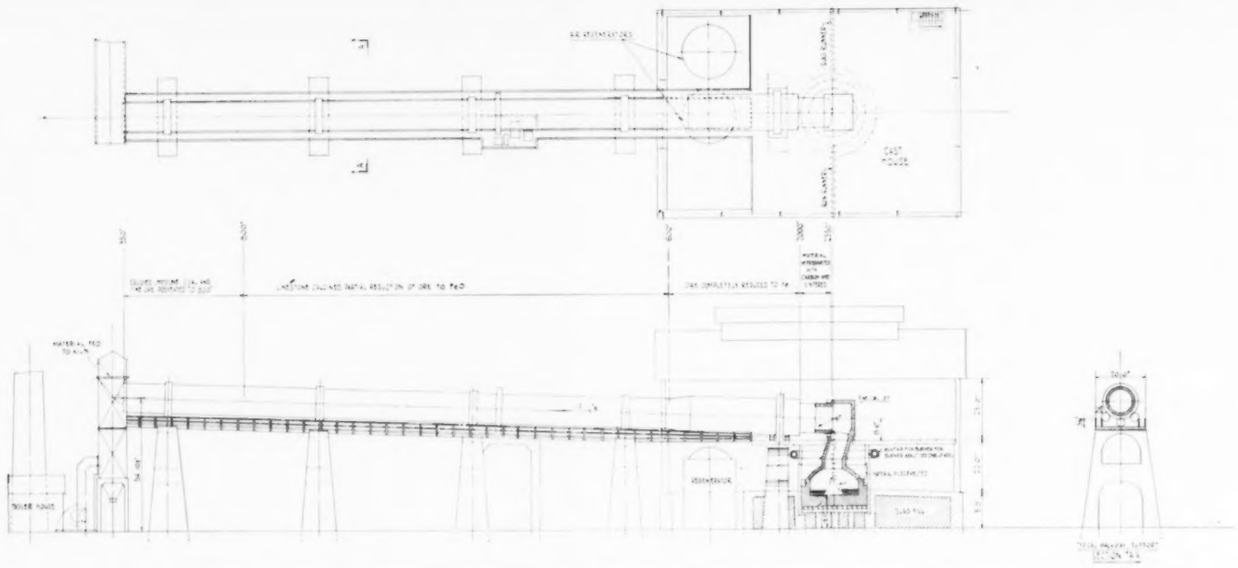


Figure 6 — Layout of furnace and kiln for direct reduction process for synthetic scrap.

carbon, sintered or nodulized and discharged into a vertical circular melting furnace.

Melting and separation of impurities — The sintered aggregate is melted in a slightly oxidizing atmosphere, the impurities passing into the slag which is continuously flushed off while the melted iron settles to the bottom and is tapped periodically.

Metallurgical principles — The iron is reduced without reducing the silica in the ore due to the absence of excess carbon. The silica in the ore combines with the calcium in the limestone, forming compounds of calcium silicates.

The manganese and phosphorous in the ore will reduce with the iron.

The sulphur in the metal is held to a trace due to the relatively high lime charge and the low percentage of coal or coke required for the metallurgical reactions.

While much of the carbon in the iron is derived from the carbon in the sinter, actual control of the carbon content is secured by carbon additions made directly to the metal bath below the slag.

The slag formed in the melting furnace is basic with a calcium oxide content of 40 per cent or over and is maintained at a desired thickness by means of the continuous flush-off.

A certain amount of iron oxide as FeO up to about 10 per cent may be carried into the melting furnace from the kiln. There will also be a certain amount of iron re-oxidized in the melting operation. To facilitate the recovery of FeO in the slag a blanket CO flame is maintained directly over the bath and unburned carbon deposited onto the pile of material and into the slag.

With the slag and metal both hot and both containing carbon, the iron oxide will revert to iron, especially so, when the slag is basic and surrounded with a reducing atmosphere. Experience has established that the FeO+ silica content of the slag does not exceed 34 per cent in slags with a CaO content of 40 per cent.

Material handling equipment — The arrangement of the handling equipment for the raw materials, consisting of track hopper, skip hoist, storage bins, drying and crushing plant and conveyors is shown in Figure 9.

An endless belt conveyor extending under the crushed material feed bins is used for feeding the materials into the kiln in order to provide intimate mixing of the aggregate.

Reduction equipment — The reduction kiln consists of a modern ore sintering kiln as previously shown in Figure 6. The lower end section of the kiln is of a reduced diameter for the purpose of creating a hot zone, where the material is rapidly sintered, while the hot gases melt any accumulation adhering to the kiln walls. A boring bar is provided for the removal of any accumulation which may adhere to the kiln walls through abnormal operation.

Melting furnace — The melting furnace is designed so as to permit the sintered aggregate from the reduction kiln to form a pile of such proportions as to prevent buoyancy and expose sufficient surface to the melting flames to give the desired production. The circular design of the furnace permits the exposure of the maximum area of material to flames of uniform intensity.

To provide for the exceptionally high temperatures, the furnace, uptake and kiln hood are lined with unburned, chrome free, magnesite brick. The furnace roof is of suspended arch construction of the same material. The uptake is further provided with water cooling. A section of the furnace together with an explanation of its features is shown in Figure 10.

Fuel preparation equipment — The fuel handling and preparation plant consists of a coal track hopper, skip hoist, coal storage and pulverizer. In order to obtain the maximum flame temperature and eliminate water vapor in the combustion gases, the powdered coal is carbon-

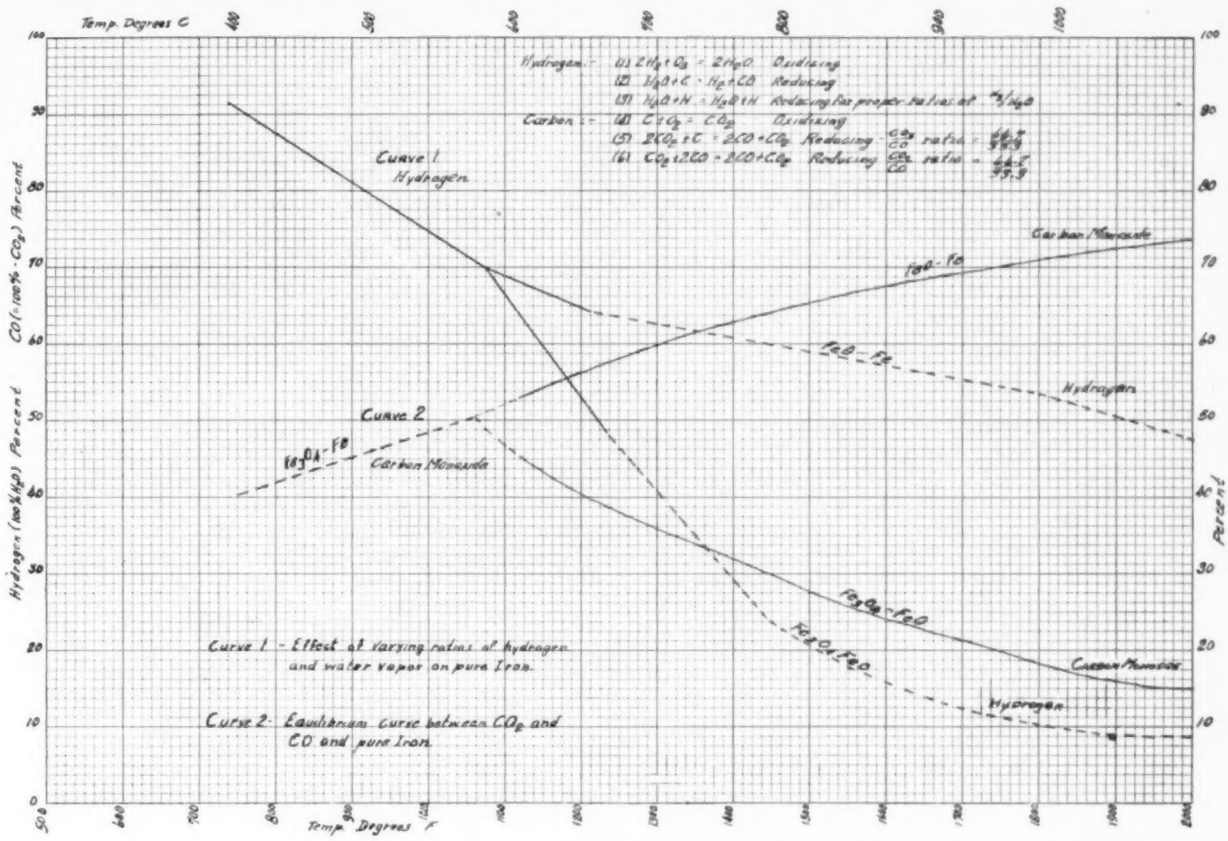
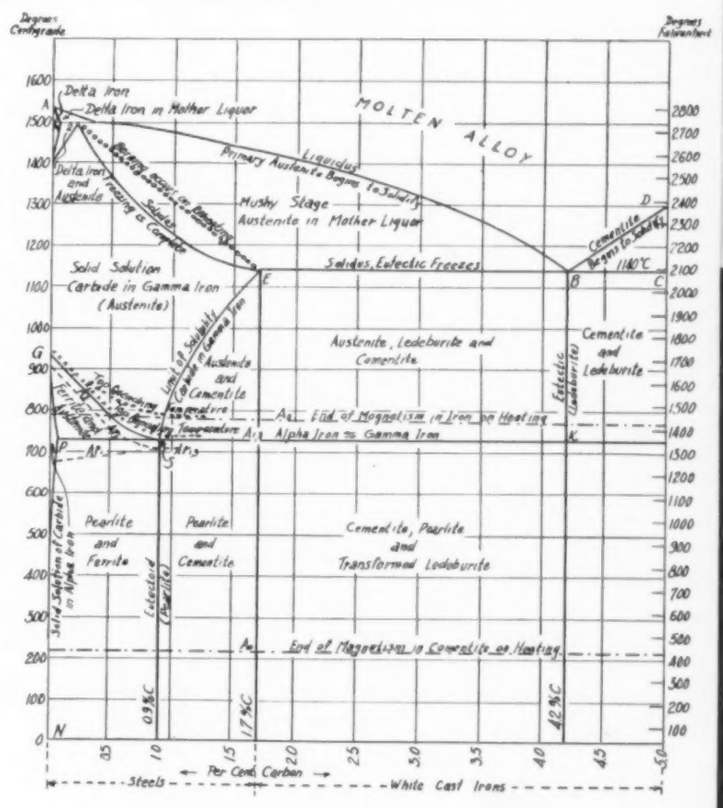


Figure 7 — Curves of equilibrium between hydrogren, water vapor and iron, and between carbon monoxide, carbon dioxide and iron.

▲

Figure 8 — Iron-carbon diagram.



ized and preheated to incandescence in a cyclone and recuperator provided for the purpose.

The operation of this unit briefly consists of injecting hot waste gases from the kiln hood and stack and a small quantity of air, into the cyclone, tangentially, to give a whirling motion to the gases. The pulverized coal is injected through the top of the cyclone and is heated in suspension to about 650 F, the surface of the coal particles being oxidized in the process. Recirculation of the coal is secured by a blower. This permits control of the degree of exposure of the coal to the gases. The coal then passes through recuperator plates where the volatile gases are distilled off and heated to about 1200 F. The surface of the coal particles being oxidized, adhesion or coking does not occur. The recuperator is heated by waste gases circulated through the plates. The distilled gas from the unit is a by-product coke gas with recoverable by-products. The arrangement of this unit is shown in Figure 11. Equipment similar to this was in successful operation for approximately ten years in the Lakeside plant of the Milwaukee Electric Light and Railway Company and is fully described in patents 1,954,350; 1,954,351 and 1,954,352.

By-product gas and tar handling equipment — A gas washer and tar precipitator together with tar pumps and storage tank is provided to handle the by-product gas and tar.

Combustion air regenerator equipment — A set of two

regenerators are provided for preheating the combustion air. The regenerators are conventional except that they are dome fired with clean by-product gas and the full cross section area is utilized for checkers. A temperature range of 1800 to 2000 F is maintained by automatic reversal control and provision is made for a constant flow of air at a straight line temperature of 1800 F.

Burner equipment — The burners for firing the melting furnace consists of twelve large powdered coal burners for melting in which ninety per cent of the furnace fuel is burned and twelve auxiliary burners set directly below the melting burners and burning ten per cent of the furnace fuel. The auxiliary burners supply the 100 per cent CO blanket flame over the bath while the melting burners are set to burn with a deficiency air so that one-ninth of the carbon is burned to CO and eight-ninths to CO_2. The average ratio of CO/CO_2 in the gases from the two flames is 20/80. This ratio is maintained by full automatic control.

In addition to the firing burners, there are two sets of carbon jets for injecting incandescent carbon into the combustion gases leaving the melting furnace to reform the CO_2 into CO through the reaction; $CO_2+C=2\ CO$. The first set consisting of twelve jets is installed through the furnace arch adjacent to the uptake while the second set consisting of the same number of jets is placed in the uptake adjacent to the furnace arch and spaced staggered with respect to the first set. This is to insure thorough impregnation of the gases.

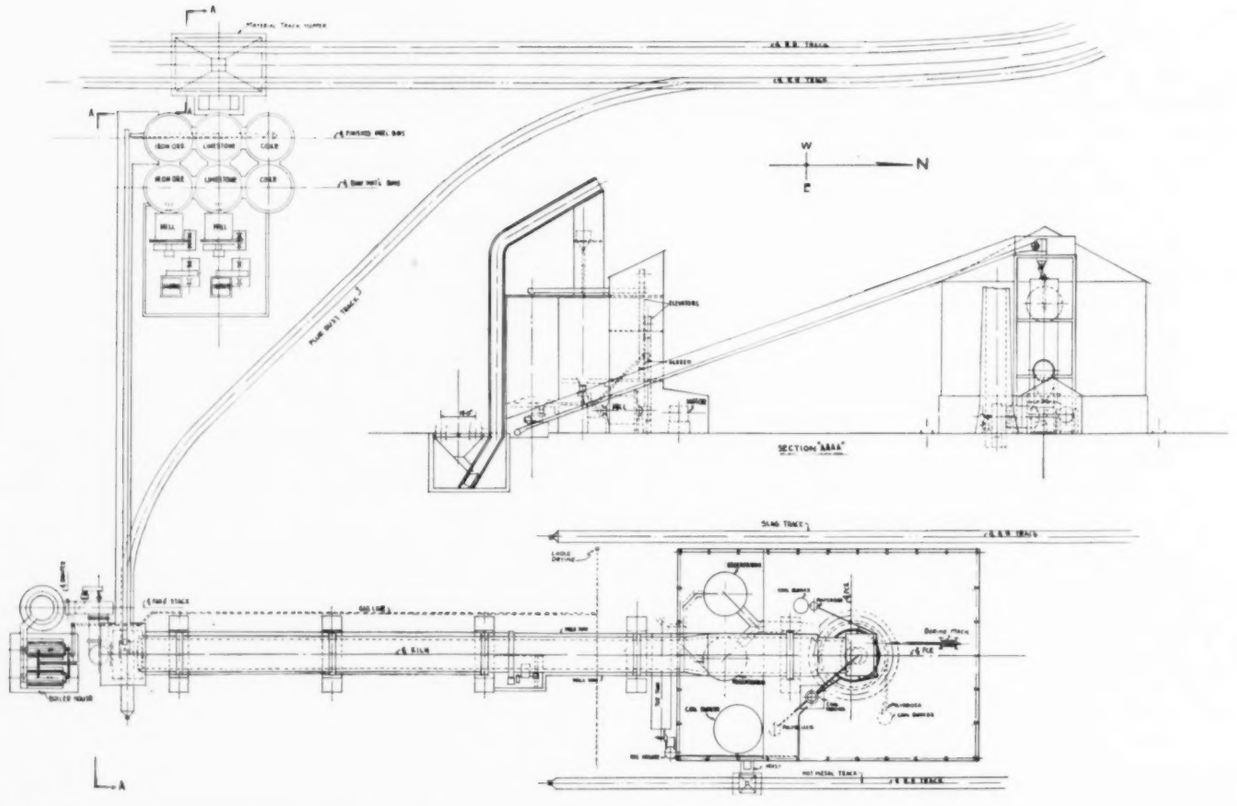
The heat content of the gases from the melting furnace is insufficient to supply all of the heat required in the kiln. To compensate for this deficit another burner is installed through the kiln hood. This burner is set to burn with a high CO flame. To simplify the control of atmospheres, the burner is set so that the analysis of its combustion gases is the same as that of furnace gases after being reformed by carbon.

Combustion control equipment — In addition to controlling the temperature reversal cycles in the regenerator, complete combustion controls will be installed on the hearth and kiln burner.

The air flow to the main firing burners in the melting furnace will be controlled through a pyrometer installed in the roof and set for about 3000 F. The air flow to the CO flame blanket, as well as the air flow to the jets for injecting incandescent carbon for the reduction of gases leaving the hearth, are controlled in proportion to the air flow to the main firing burners. The fuel flow will be automatically proportioned to the air flow. In this way the ratio of the carbon monoxide to carbon dioxide content of the gases in both furnaces is automatically held at the desired point.

When the temperature of the melting furnace reaches 3000 F the fuel input is automatically reduced. As a

Figure 9 — General arrangement of plant, showing track hopper, skip hoist, storage bins, drying and crushing plant, and conveyors.



result of this decrease in the fuel input to the melting furnace, the temperature of the gases passing from the furnace to the kiln will drop and the fuel input to the burners firing directly into the kiln will be increased by the temperature impulse set up by the radiation pyrometer in the kiln hood.

The amount of high temperature heat required in the melting furnace is 1352 Btu per lb of product. The heat required in the kiln is 3004 Btu per lb of product. In normal operation one-half of the fuel burned will be fired through the melting furnace burners.

The required ratio, however, is automatically controlled by the radiation pyrometers. Both the reducing kiln and melting furnace are under constant control

Figure 10 — Section through furnace.

The pile of material shown in the melting furnace is carbon impregnated iron and slag sinter. The pile is maintained at such a height as to prevent buoyancy and to provide melting surface for the melting flame. The desired height is maintained by controlling the rate of material flow from the kiln and the amount of fuel fired for melting the material.

A reservoir of about 18 in. metal is maintained in the bottom of the furnace at all times. This metal acts as a mother liquor. The tap hole or iron notch is located on a level with the top of the metal reservoir.

Additional carbon is added to the metal as required, through the refractory tubes "p." Electrodes are installed at points "M" on the plan for the purpose of insuring sufficient temperature of metal at all times. The refractory tubes for carbon are omitted at points "M" when electrodes are installed.

Flame "A" fired from 12 burners equally spaced around the circumference of the furnace arch is the melting flame, firing 90 per cent of the fuel. This flame is slightly oxidizing with 8/9 of the carbon burning to carbon dioxide and 1/9 to carbon monoxide.

Flame "B" fired from 12 burners directly below the "A" flame burners, is a 100 per cent CO flame and also impinges unburned carbon onto the material pile and surface of the bath. This flame acts as a carbon monoxide blanket through which the heat from flame "A" radiates.

Burners "C" located directly above the "A" flame burners, inject incandescent pulverized coke for the purpose of converting the carbon dioxide in the exit gases into carbon monoxide. The burners "D" are for the same purpose. They are spaced staggered with respect to "C" burners and give the effect of carbon depth or a carbon bed to insure impregnation of the exit gases.

Burner "E" furnishes a highly reducing flame. As it is fired with 1800 F air and incandescent coke it will also be of a relatively high temperature.

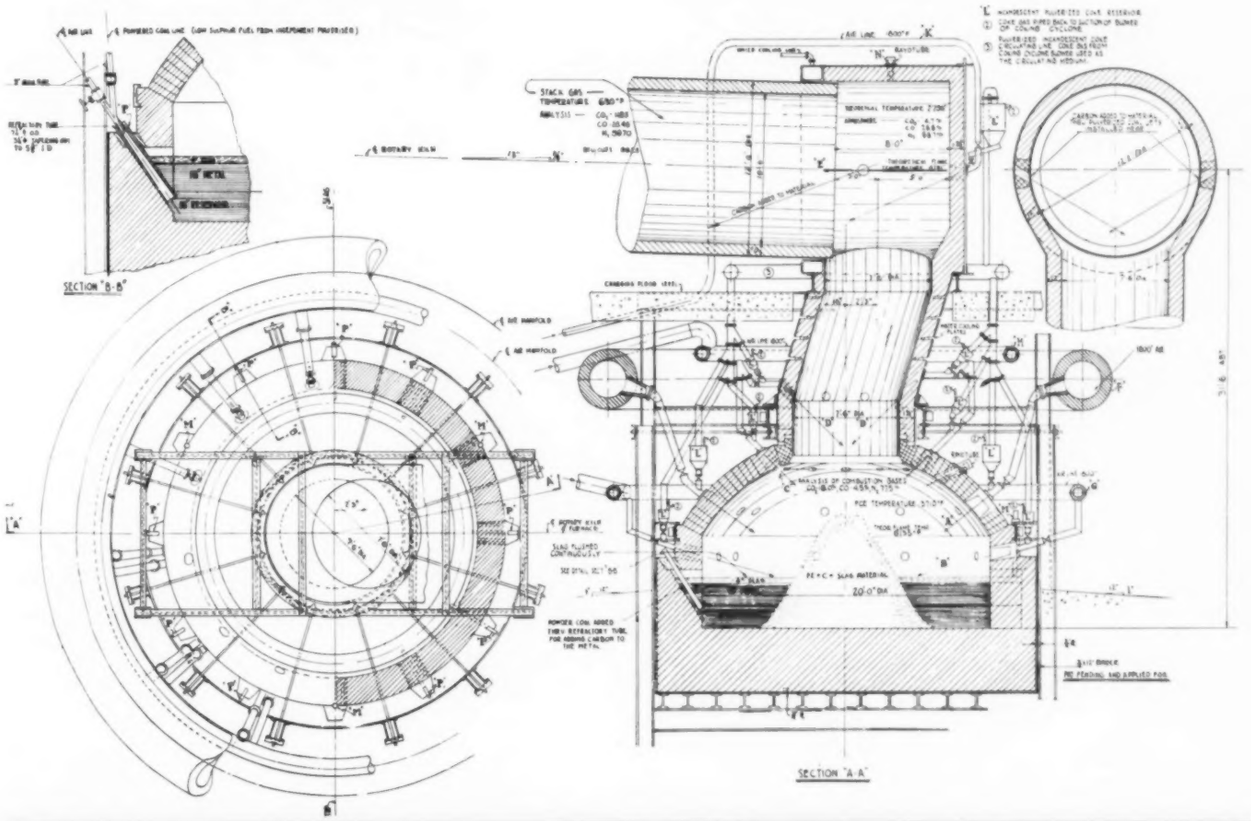
The combustion controls for firing the furnace and kiln are as follows:

A radiation pyrometer installed in the roof of the melting furnace furnishes impulses when the reflected temperature varies from normal. The air supply to the bustle pipes "F", "G" and "H" is varied by means of butterfly valves operated from the impulse set up by the pyrometer.

Incandescent pulverized coke is fed to coke reservoirs "L" by means of a blower, using the exit gas from the cyclone of the coking unit as a conveying medium. The gas is tapped off from the reservoirs "L" and piped back to the coke cyclone, or to the suction of the blower drawing gas from the cyclone. Incandescent coke from the reservoirs "L" is fed to the burners by a motor driven screw feed attached to each burner. These motors are but of a fraction of a horse power each and are not shown on the drawing.

Orifice plates with pressure taps are installed in the air lines supplying bustle pipes "F", "G", and "H". As the air supply is varied by the action of the pyrometer, the differential across the orifice in each respective air supply line varies and furnishes an impulse from which the speed of the motors, driving the pulverized coke feed to the burners, is varied. This is the conventional method of combustion control, i.e. control of air flow from temperature, and proportional control of fuel from air flow.

The control of kiln burner "E" is identical to that for the melting furnace with the exception that the impulses are received from pyrometer "N" installed in the kiln hood. As the fuel to the melting furnace is decreased, the temperature in the kiln hood drops and the fuel input through burner "E" is increased, indirectly, through impulses received from pyrometer "N".



as to the ratio of CO/CO_2 content of the products of combustion by the fuel-air ratio controls operated from impulses set up by the pyrometers. In addition to this, the melting furnace and kiln will be provided with automatic draft control to further facilitate regulation.

The installation of the fuel equipment outlined above permits the supply of all of the high temperature heat required for melting and the separation of impurities from the metal without in any way conflicting with the reducing atmosphere required in the kiln for reduction — a feature not heretofore available in any direct reduction process developed to date, and the use of which distinguishes this process fundamentally from any other.

Metal temperature control equipment — To provide for any contingency which may result in the metal bath chilling to a point lower than that required for reactions between the slag and metal, three electrodes are installed in pockets recessed in the side walls of the furnace below the metal line and 120 degrees apart. As these electrodes merely act as temperature boosters, the current consumption will be very low. This together with the fact that they are not normally used, bring the current consumption per ton of product to less than sixty kilowatt-hours.

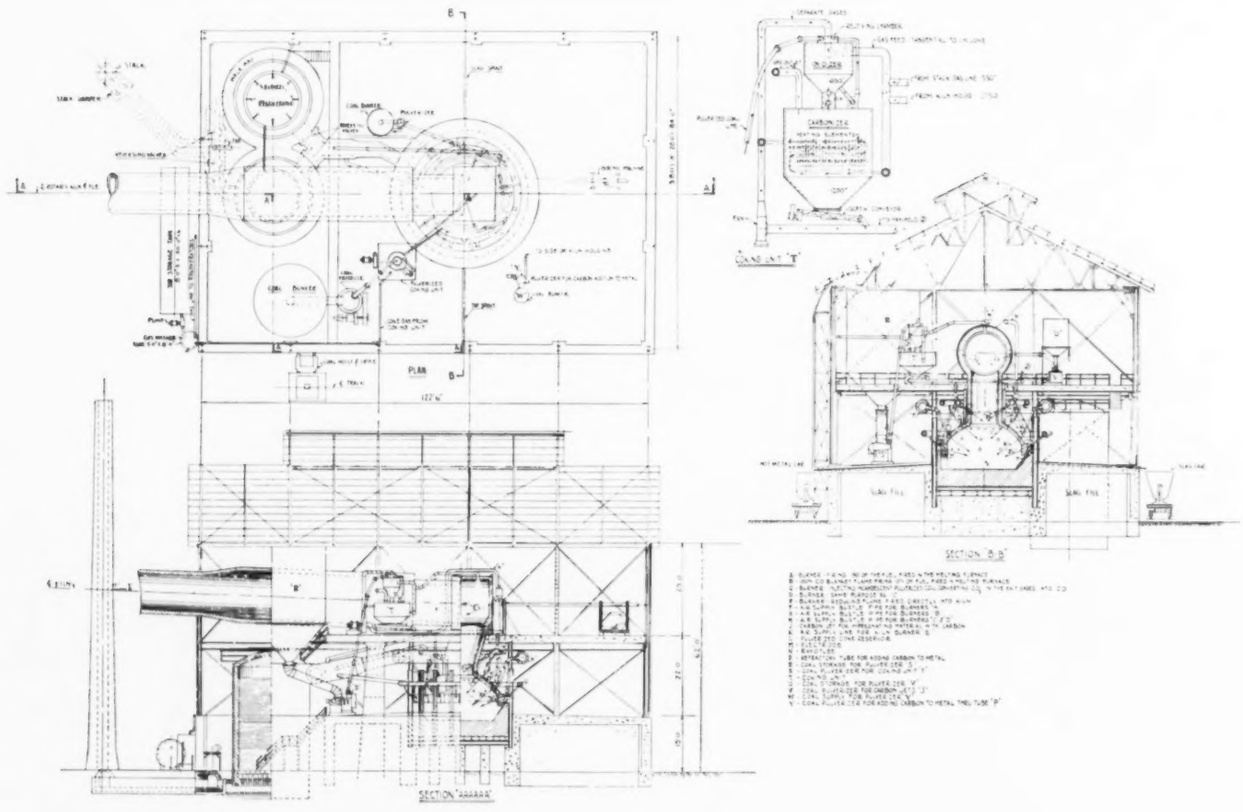
Equipment for making carbon additions to metal — In order to provide for carbon additions to the metal, refractory tubes are placed in pockets recessed in the side wall of the furnace thirty degrees apart in the same manner as that used for the electrodes. Three of these pockets are used for electrodes as previously outlined and hence, the refractory tubes omitted from them. Pulverized coal, coke or charcoal is injected through the refractory tubes by air at fifteen pounds pressure. As it is desirable that the carbon thus added be exceptionally low in sulphur, an independent pulverizer and coal storage bin are installed so that metallurgical fuel may be separated from combustion fuel.

Equipment for adding carbon to the sinter — In addition to the above, another coal pulverizer is installed for supplying the crushed coal to the material at the sintering zone of the reduction kiln. The coal added at this point is a relatively coarse aggregate whereas the pulverizer supplying the carbon for the metal bath gives a relatively finely ground aggregate.

In addition to the major items of equipment mentioned in the foregoing, there will be required the usual complement of hot metal ladles, cinder ladles and ladle cars.

The metal produced at the above noted rate of 400 tons per day may be cast into pigs of synthetic scrap. In this case the necessary pigging provisions must be made. Normal practice will consist of charging the hot metal directly into the refining furnace.

Figure 11 — Sketch showing additional elements of design of direct reduction plant.



Slit It Open and SEE the Difference

Two important factors govern the selection of wire and cable for "hot-spot" service in steel mills, power plants and various vital industries. First, the conditions under which the circuits must operate, such as around soaking pits, boilers, furnaces, steam lines, drying ovens, rheostat grids; places where resistance to heat and moisture, corrosive fumes, oil, grease and even fire is essential. Second, and most important, is the construction of the wire—its in-built ability to stand up under these severe conditions.

Rockbestos A.V.C. Power, Motor Lead and Lighting Wires and Cables (Underwriters' and N.E. Code, Type AVA) meet the requirements of "hot-spot" service with permanent insulation that won't bake brittle, crack, bloom, swell or rot and has a maximum operating temperature rating of 110° C. (230° F.).

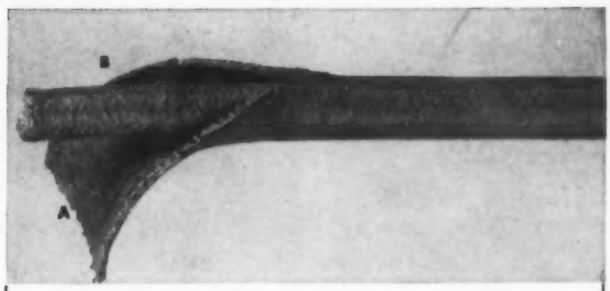
Apply the knife-test to a sample of Rockbestos A.V.C. and you'll find the answer to production losses and unnecessary maintenance due to wire-failure beneath the braid. Send for a sample and dissect it yourself. Rockbestos Products Corporation, 877 Nicoll St., New Haven, Conn.

ROCKBESTOS A.V.C.

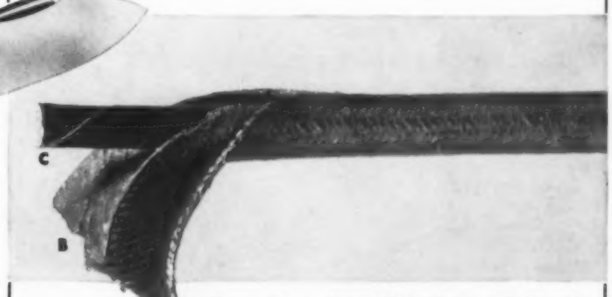
The Wire with Permanent Insulation

122 different permanently insulated wires, cables and cords

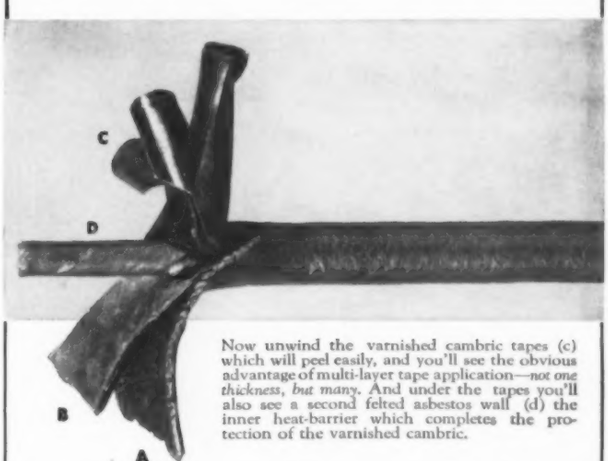
developed by Rockbestos for various severe operating conditions



Take a sample of Rockbestos A.V.C. Power Cable, illustrated, or similarly insulated Motor Lead Cable, slit open the slick-finished heavy, heatproof, fireproof asbestos braid (a) which is resistant to moisture, oil and grease, and you'll find beneath a firewall of felted asbestos (b) a permanent heat-barrier against high ambient temperatures.



Then cut through this felted asbestos wall (b), peel it back, and see the high-dielectric moisture-resistant varnished cambric tape (c) it protects from heat, flame and oxidation. Notice too, the uniform coverage of the tapes, helically applied like the felted asbestos to assure perfect and permanent centering of the conductor in the insulation.



Now unwind the varnished cambric tapes (c) which will peel easily, and you'll see the obvious advantage of multi-layer tape application—*not one thickness, but many.* And under the tapes you'll also see a second felted asbestos wall (d) the inner heat-barrier which completes the protection of the varnished cambric.

Finally, slit and peel back this felted asbestos wall (d) which prevents conductor-heating overloads from breaking down the varnished cambric and won't burn even when exposed to copper-melting arcs, and you'll see the paper separator (e) that keeps the conductor clean of insulation and makes stripping easy. And that completes the story of Rockbestos A.V.C. *the wire with permanent insulation.*

NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.

Developments IN THE IRON AND STEEL INDUSTRY DURING *1942*

W. H. BURR

by W. H. BURR, CHAIRMAN
A. I. S. E. DEVELOPMENT COMMITTEE
AND ELECTRICAL SUPERINTENDENT
LUKENS STEEL COMPANY
COATESVILLE, PENNSYLVANIA

86,000,000 tons of steel!

What a figure for statisticians to play with, offering figures as to how many times it would go round the earth or how long it would take a housewife to open all the cans which could be made from it. Of more immediate moment, however, is how many ships and tanks and guns this new annual record production of steel will make — and still we find the answers at variance: "Not enough," "Enough," "Too little," etc.

It has been stated that the man-hours required for fabricating armament products range from a mere fraction per pound of shells up to 35 man-hours per pound for airplane motors. Whether these figures are accurate or not, they serve to indicate that the amount of steel which can be used depends on the use to which it is put. To fabricate our entire steel production into airplane engines would require the man-hours of about 40 times our total labor supply!

So complicated is the job of coordinating our vast facilities into a balanced plan of armament and ordnance production (and balanced it must be) that many inconsistencies and contradictions have shown up. This is evidenced by curtailment in some lines of production, not all of which is occasioned by lack of steel.

A number of basic expansion projects have proceeded under the curtailed program announced last summer. Some of this is in the form of additions to existing plants, while some is in the nature of completely new integrated plants. The expansion is scattered widely over the country, with the western part of the country having a goodly portion. A considerable part of the new capacity is planned to go into production by mid-1943, when a total annual ingot capacity of about 98¼ million tons is expected.

However, in spite of extended control by WPB over many types of industrial equipment, including conveying machinery, mechanical power transmission, fans, blowers, compressors, pumps, electric motors and controls, trucks, steam engines, heat exchangers, elevators, etc., it seems that several expansion projects are running behind schedule. Included in these projects are many which would aid in relieving our serious "bottlenecks." Ironically, some of the delay may be traced back to a lack of some steel material which the equipment manufacturer is unable to obtain, and which the steel companies are unable to supply them because of production schedules in accordance with WPB rulings. Better overall planning and coordination along this line would do much to aid our war program.

Throughout the year, announcements of new production records came thicker than snowflakes in the blizzard of '97. Many notable achievements were included. Also included were many "paper" records, adding little to the overall effort. It seems that some producers hope to smother our enemies in a veritable avalanche of hourly, turn and daily records, of records on auxiliary equipment, man-hours, etc. It is questionable whether all of this bally-hoo stirs us to new efforts or lulls us into a complacent feeling that we are doing our utmost.

With the number of employees at a record high in spite of many old employees taken into the armed forces, the man-power question has been a serious one to the steel industry. The problem has been met by extensive training programs designed to improve old employees as well as break in new ones. Female help has been used to an extent previously undreamed of, particularly in those areas where new armament and ordnance plants have made the labor supply tighter than would otherwise be the case. In such districts, the steel plants are using women as mill clerks, recorders, observers, welders, machine operators, crane operators and mill operators, and it is stated that some may be put into labor gangs. In these capacities, long exclusively male, women are giving satisfactory performance, and have been of great help in meeting the man-power problem.

Plans to protect plants against possible damage from air raids have been established by most of the larger companies in the steel industry, particularly those located in what might be termed critical areas.

In general, plans for air raid protection of steel plants have three major divisions:

1. Creation and training of an effective organization consisting of both staff and field forces.
2. Design and installation of the special equipment needed, such as, communications systems for receiving and disseminating raid warnings and maintaining contacts between staff and field personnel during a raid.
3. Direct air raid precaution work within the plants, including the working out of details of handling machinery and metal in process, provision of shelter for employees, and protection against damage from sabotage during blackouts.

Figure 1 — With a production goal of 68,000,000 tons of pig iron for 1943, many new blast furnaces have been placed in operation, with more under construction.

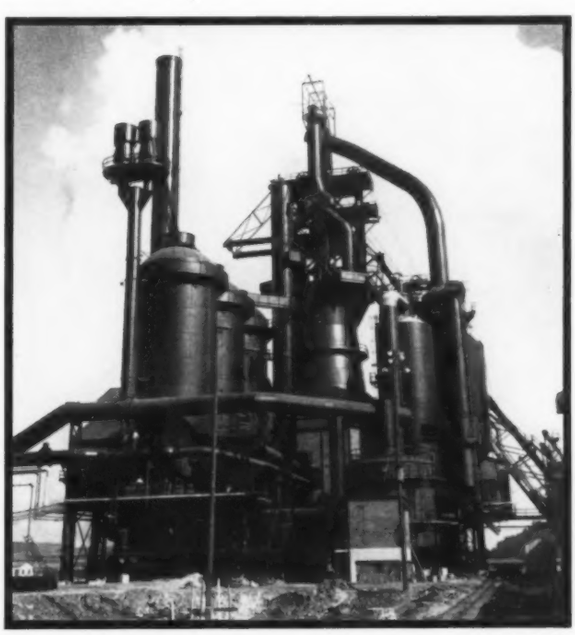


Figure 2 — By building this new blast furnace on a special undercarriage and moving it into place, the loss of 90 days of pig iron production was avoided.

Experience in test blackouts in various steelmaking centers has shown that steel plants can be adequately darkened during the period of time which might be expected between receipt of the first warning of an impending raid and the actual time when the raiders would arrive over the plant. Protection plans have been designed to keep the maximum number of men at work during any emergency so that interruption of production may be held to a minimum. In general, air raid precautions call for plant black-out in case of alarm, during which no casts or taps are to be made, furnaces will be shut down or shielded, rolling will cease, and lights will be turned out.

BLAST FURNACES AND COKE PLANTS

With a projected goal of 70,000,000 tons of pig iron production in 1944, the past year was studded with announcements of new furnaces being blown in, and the coming year will show even more. Production for 1942 will approximate 59,300,000 tons, with 68,000,000

tons projected for 1943. The new capacity, for the greater part, consists of installations built by the steel companies under government financing, with some private construction, and some additional gain coming from rebuilding and enlarging.

The first blast furnace completed under the government plan for expansion is of 23 ft 6 in. hearth diameter, with a 28 ft bosh and a 19 ft 6 in. stock line. Sixteen tuyeres are installed. Blast for the furnace is dehumidified in a conditioning plant located on the intake side of the turbo-blower and capable of maintaining 1-3 grains of moisture. There are three stoves, 25 ft x 115 ft. Gas from the furnace is cleaned by passing through a dust catcher, a washer, and two electric precipitators.

Another furnace, also built under the government plan by the same company, has a 25 ft 6 in. hearth, a 28 ft 3 in. bosh, and a 19 ft 6 in. stock line. This furnace, totaling 107 ft 3 in. stack height was the second furnace built for the Defense Plant Corporation to be placed in operation. (Complete details of this furnace are published elsewhere in this issue.)

In order to avoid losing approximately 90 days production of pig iron, one plant built a new 1050 ton furnace on a specially constructed undercarriage, meanwhile keeping the old furnace in operation. According to schedule, the old furnace was blown out and dismantled, and the new shell, complete from mantle ring up, was moved on rollers to the revamped foundation, and lowered upon its columns. Thus, furnace outage was less than three months, as compared to about six months for regular construction procedure. The new furnace has a 23 ft hearth, a 26 ft 6 in. bosh and a 19 ft stockline, with a height of 100 ft.

Well worthy of mention was the feat accomplished by one company in dismantling an old furnace and erecting a new one in the span of 70 days.

The monthly production record for a single blast furnace has crept steadily upward all year. Starting in January with 41,782 tons, this record has passed around among the various producers and was set for the fifth time in October, when a figure of 46,246 tons was reported. There is still belief in some quarters that a number of the furnaces in the country could be stepped up simply by blowing harder. Perhaps the work undertaken by the Advisory Committee for Increasing Coke and Iron Production will prove or disprove this.

Figure 3 — With the use of sintered material showing marked results on blast furnace operation, many sintering plants have been built, and more may be expected.

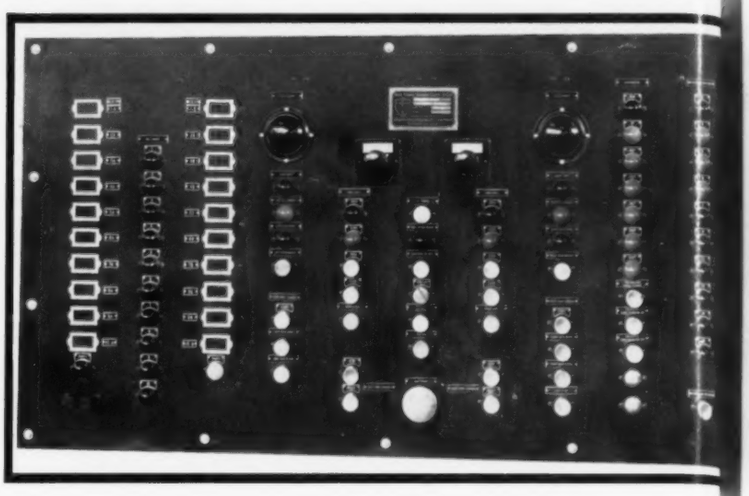


Figure 4 — Typical master panel for blast furnace charging control, distributor control, automatic coke charging control and stockline recorder.

The expansion of blast furnace capacity and the modernization of old furnaces have brought considerable activity to the instrument and control field. Almost every furnace now uses automatic hot blast control, wherein a thermocouple, located in the hot blast main near the bustle pipe, actuates a controller, which in turn operates a mixing valve. Through this valve, enough cold air is automatically introduced into the hot blast to maintain a constant blast temperature. When the mixer valve closes entirely, a signal warns the operator that the stove has reached the minimum temperature, so that another stove may be put on blast. By tying in the operation of the mixer valve and the stove valve to work in tandem, the size of the mixer air line can be greatly reduced.

The majority of modern furnaces also have installed recorders showing the temperature of dome, exit waste gas, and exit air on each stove, as well as a recorder on furnace top or downcomer temperature.

So great is the output of the modern furnace that even small improvements in operating efficiency may lead to big savings. By automatically controlling, or by enabling the furnace operators to see, the various temperatures existing in the furnace system, heat may be governed as precisely as other items of operation, and smoother, more economical operation, with greater production, may be attained.

New systems of control have been developed and placed in operation for skip hoists, affording better operating characteristics with simpler equipment. These systems, together with automatic charging control systems, have resulted in material increases in production in a number of cases.

Blast conditioning, concerning which several glowing reports have been made, continues to be more or less

of an enigma. A considerable number of installations have been made, with reported results at considerable variance. Some operators state that they cannot tell the difference whether the blast conditioning system is working or not. Others refuse to promise any increase in production as a result of blast conditioning. In fact, some data has been presented to the effect that operation is actually benefited by adding moisture to the blast. Thus we find a possible improvement stymied by a lack of concrete, authentic information. Granted that accurate determination of such results presents an involved, long range problem, the industry needs the answer and will be indebted to the individual or company finding it.

In a survey of the iron ore situation (*Iron and Steel Engineer*, November, 1942), M. D. Harbaugh contrasted the low point of 3,500,000 tons of lake ore shipped only ten years ago to the 81,000,000 tons shipped in 1941 and the 92,000,000 tons probably to be shipped this year. He gave probably 1943 ore requirements as 100,000,000 tons of lake ore, in addition to the increased requirements from southern and western fields.

To meet these demands, most of the lake region mines are being crowded to capacity, and new mines have been and are being opened. Important additions are under way in New York and New Jersey which will almost double the north-eastern output. Expansion is under way in Wyoming, Missouri and Alabama.

The reserves of commercial grades of ore are distinctly limited, and annual shipments at the rate of 100,000,000 tons cannot long be maintained. The situation is such that the mining industry is giving immediate attention to plans which were formerly thought to be considerably in the future, namely the production of high grade furnace feed by large scale concentration of the iron bearing rock — the taconites — of the Lake Superior ranges. This rock, which contains 25-30 per cent iron and twice as much silica, occurs in practically unlimited quantity. Extensive areas of the taconite are magnetic, and it is this magnetite which is most amenable to concentration by present methods. Other areas embrace hematites and carbonates, from which commercial products eventually may be obtained. This points to intense activity in all lines of equipment pertaining to ore beneficiation.

With the lake shipping season practically closed by weather conditions early in December, total ore shipments for the year totaled approximately 92,000,000 tons. Further extension of shipping was held to be unwise, as the loss of a carrier would reduce the potential carrying capacity for next year.

Mr. Harbaugh stated that while iron ore mines have experienced troubles similar to other industries in obtaining equipment and supplies, production in general has not been held up. Now, however, the threat of labor shortages is ominous, and operators are apprehensive that the mines may be up against the same labor problem that already has reduced the output of vital non-ferrous metals in many western districts.

To protect the flow of iron ore to the mills and to insure continued shipments of ore from the upper Great Lakes region, an auxiliary route has been mapped, entailing construction of ore yards and docks at Escanaba, Michigan, the possible dredging of additional channels at Escanaba Harbor, and improvements of the railroads connecting Escanaba with Superior, Wisconsin and Ironwood, Michigan. This new route, which is supplementary to the present one through the Soo locks, will be adequate to handle annual shipments of 100,000,000 tons of ore. According to the Office of Defense Transportation, 40,000,000 tons could be moved from the Duluth area to Ohio and Pennsylvania furnaces by rail, while 60,000,000 tons could be moved from the Michigan ranges and from Duluth, either by all-rail route or by water and rail via Marquette, Michigan. This tonnage would be shipped from Escanaba by water, thus shortening the time required for the boat trip.

Ore preparation and beneficiation continues to hold the interest of the industry as the development which will show the greatest results in improving blast furnace operation. As previously mentioned, beneficiation will of necessity increase as the quality of ore drops off.

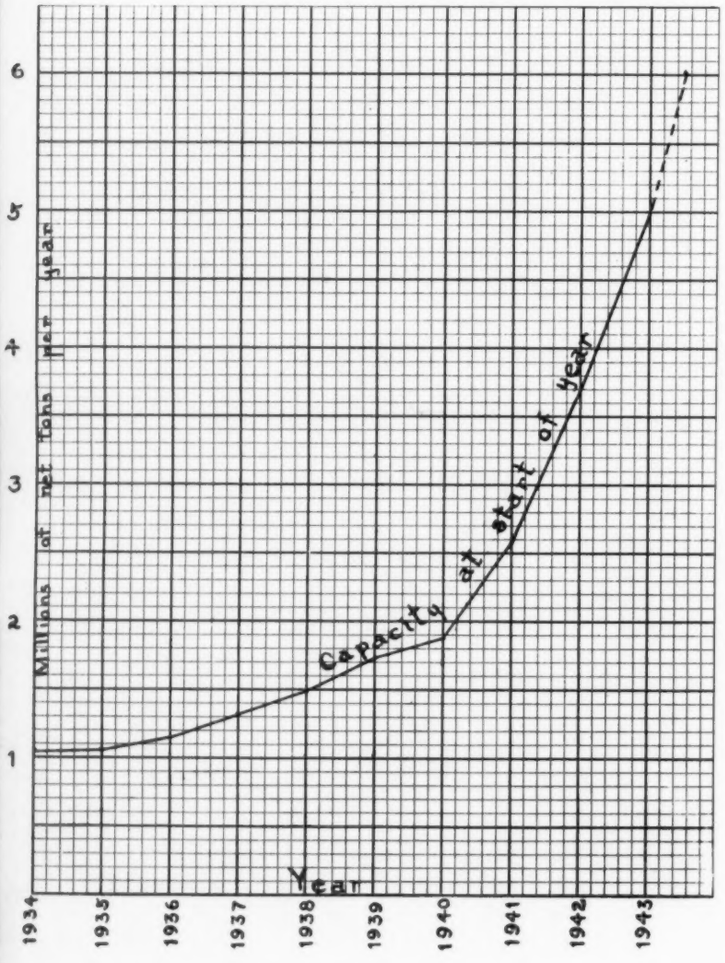
The expansion in pig iron capacity is accompanied by a necessary expansion in coking facilities, projected at 1904 new by-product ovens and 344 rehabilitated ovens, plus new and rehabilitated bee hive ovens. The aim for 1944 is 70,000,000 tons of by-product coke and 9,000,000 tons of bee hive coke, an increase of about 13 per cent over the total 1942 production. Most of the new blast furnace projects are accompanied by new by-product coke plants. There is, however, a marginal demand which must be met by the bee hive ovens, particularly in western Pennsylvania, where practically every steel producer is to some extent dependent on this supply. It is essential that the beehive ovens continue to operate to supplement the output of the by-product plants, yet a curtailment of operations is

Figure 5 — Fifty-two electric arc furnaces, for the greater part of large size, have been added to ingot-making facilities of the United States during 1942.

threatened by the exhaustion of their nearby mines and by a labor shortage. Some of these plants have been forced into going farther afield for their coal supply. Some have been forced into using coals previously thought unsuitable, with the result that blast furnace operation suffers from the high ash and high sulphur contents of the coke. If production is not to suffer, some action is required which will enable the beehive plants to continue operation.

A number of new by-product coke oven plants have been built embodying a unique method of securing controlled enrichment of lean gas in order to maintain high coking rates in ovens underfired with blast furnace gas. Enlargement of oven chamber dimensions over the past 20 years was accompanied by two fundamental problems: The flow of greater volumes of combustion gases in the larger ovens had to be modified so as to minimize pressure differentials in the heating system, and the higher ovens and higher flues required modified methods of heating to obtain uniformity.

Figure 6 — The rapid growth of electric furnace capacity is indicated by this curve, which shows an annual capacity of 6,000,000 tons of ingots by mid-1943.



The new design uses new heating methods that are radical departures from those used heretofore, and has resulted in improved coke quality and more efficient oven operation. All of this has been accomplished without increasing construction costs, and without sacrificing the original principles of design which were characterized by low pressure differentials and complete absence of counterflow of either rich or lean fuel gas and air. Using recirculation of waste gases and a controlled enrichment of lean fuel gas, the new heating principle tends toward greater uniformity in oven wall heating, and, with a coal charge of uniform moisture content, uniform blending, uniform pulverization and uniform charging, coke of uniform quality must result. More than 1100 ovens of this new design, in 24 batteries, are in operation or under construction.

Considerable interest has been evidenced in coal washing as a means of improving coke through a reduction of the ash and sulphur contents. Various reports show an increased yield of furnace coke, and blast furnace operation is benefited by a reduced slag volume, permitting a heavier ore burden. Tests have shown that blast furnace production is thus increased by 5-8 per cent, or approximately 5 per cent for each one per cent reduction of ash in the coke.

STEEL MAKING

The national scrap drives have brought together a great amount of scrap of various sorts, and have definitely eased the critical situation of last summer. Steel plants report a general increase in their scrap supply. and a considerable stock of scrap has been accumulated elsewhere. Much of this, however, is of a type which requires careful sorting and preparation before it can be used in the steel plants.

While the quantity of scrap has improved, the quality has gradually fallen off, and complaints are general. In some cases, one open hearth furnace in a shop may be used to melt down inferior scrap, skulls and metallic refuse into a product which may then be used in the production of quality steels.

The use of blown metal in a duplexing operation is practiced in some cases and may become more general as our pig iron capacity grows.

In the electric furnace field, complaints about scrap quality are long and loud. In order to help this situation, one producer is proceeding with the construction of a sponge iron plant under government financing, planning on using the product as a charge material for their electric furnaces. Desulphurized coke oven gas will be used as the reducing agent, and the ore is to be a concentrated magnetite containing approximately 68 per cent iron.

The ore will be charged into a vertical roaster where it will fall through a series of inclined hearths. The reducing gas at 1200 F will pass upward through the roaster in continuous contact with the ore. After losing part of its hydrogen content, the gas will be returned to the general plant fuel system. A daily production of 100 tons is expected. The final product is expected to run 80-85 per cent iron. It is thought that the plant will be of use only during the shortage of uncontaminated scrap for electric furnace use.

INGOT-MAKING ELECTRIC FURNACES

of the United States

INSTALLED AND UNDER CONSTRUCTION JANUARY 1ST, 1943

Company	Location	Number	Nominal size, tons	Approximate shell diameter, ft.-in.	Make of furnace	Transformer capacity, kva.	Diameter of electrodes, in.	Estimated annual capacity, tons
Adirondack Foundry & Steel Co.	Watervliet, N. Y.	1	10	11–0	Lectromelt	5,000	14	17,000
Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	2	35	16–0	Swindell-Dressler	10,000	18	
		2	25	15–0	Swindell-Dressler	7,500	18	
		2	6	11–6	Swindell-Dressler	3,000	12	
		2	6	11–6	Swindell-Dressler	2,500	12	
		1	6	11–0	Heroult	1,667	12	
		1	¼	....	Swindell-Dressler	175	4	284,000
	Dunkirk, N. Y.	1	15	12–0	Heroult	....	12	
		2	6	11–0	Heroult	....	..	65,600
	Watervliet, N. Y.	2	6	11–0	Ludlum	....	..	
		1	2	8–0	Ludlum	....	..	27,600
A. M. Byers	Ambridge, Pa.	2	25	15–0	Heroult	7,500	..	90,000
American Rolling Mill Co.	Middletown, O.	1	3	9–0	Lectromelt	2,000	..	
		4	7	11–0	Heroult	4,000	14	60,000
Andrews Steel Co.	Newport, Ky.	2*	60	18–0	Heroult	12,000	20	
		1*	25	14–6	Heroult	7,500	16	160,000
Babcock & Wilcox Tube Co.	Beaver Falls, Pa.	1	7½	12–0	Swindell-Dressler	6,000	..	18,000
Bethlehem Steel Co.	Bethlehem, Pa.	2	50	18–0	Lectromelt	15,000	20	
		1	25	15–0	Swindell-Dressler	7,500	18	
		1	6	11–0	Lectromelt	4,000	12	
		4	¼–½	....	Ajax Induction	....	..	180,000
	Steelton, Pa.	1	6	11–0	Heroult	2,000	..	9,000
Braeburn Alloy Steel Co.	Braeburn, Pa.	2	6	11–0	Heroult	1,500 and 3,000	..	18,000
Cabot Shops, Inc.	Pampa, Texas	1	5	10–0	Heroult	2,000	..	10,000
Carnegie-Illinois Steel Corp.	Duquesne, Pa.	1	70	20–0	Heroult	15,000	20	
		1*	70	20–0	Heroult	15,000	20	
		1	35	15–8; 18–0	Heroult	12,000	20	
		1	5	10–0	Heroult	3,000	..	203,000
	Johnstown, Pa.	2	3	9–0	Heroult	1,500	..	6,000
	South Chicago, Ill.	2	70	20–0	Heroult	15,000	20	
		1	35	15–8; 18–0	Heroult	12,000	20	
		3	25	15–8	Heroult	3,435	20	
		2	3½	....	Ajax induction	....	..	336,000
Carpenter Steel Co.	Reading, Pa.	4	6	11–0	Swindell-Dressler	4,000	..	
		2	½	....	Northrup Induction	....	..	65,000
Colonial Steel Co.	Colona, Pa.	1	5	10–0	Heroult	2,000	..	8,000
Columbia Steel Co.	Torrance, Cal.	1	3	9–0	Heroult	2,500	..	
		1*	25	12–8; 14–8	Heroult	7,500	16	49,000
Columbia Tool Steel Co.	Chicago Heights, Ill.	1	6	11–0	Lectromelt	....	..	
		1	3	9–0	Lectromelt	2,500	..	20,000
Connors Steel Co.	Birmingham, Ala.	2	3	9–0	Lectromelt	....	..	
		1	2	9–10	Lectromelt	3,750	10	24,000

Columbia Steel Co.	Torrance, Cal.	1	3	9–0	Heroult	2,500	..	
		1*	25	12–8; 14–8	Heroult	7,500	16	49,000
Columbia Tool Steel Co.	Chicago Heights, Ill.	1	6	11–0	Lectromelt	....	..	
		1	3	9–0	Lectromelt	2,500	..	20,000
Connors Steel Co.	Birmingham, Ala.	2	3	9–0	Lectromelt	....	..	
		1	8	9–10	Lectromelt	3,750	10	24,000
Copperweld Steel Co.	Warren, Ohio	1	35	17–0	Lectromelt	12,000	18	
		4	35	16–0	Swindell-Dressler	12,000	18	
		1*	35	16–0	Swindell-Dressler	12,000	18	
		1	6	11–0	Lectromelt	5,000	17	
		2	6	11–0	Heroult	2500; 5000	17	350,000
Crucible Steel Co. of America	Harrison, N. J.	3	15	14–8	Heroult	6,000	..	
		3	6	11–0	Heroult	3,000	..	
		3	6	11–0	Swindell-Dressler	3,000	17	
		1	3	9–0	Heroult	1,500	..	
		1	1	....	Ajax Induction	....	..	
		2	300 lb.	....	Ajax Induction	....	..	238,000
	Pittsburgh, Pa.	2	6	11–0	Heroult	....	..	
		3	1	....	Ajax Induction	....	..	32,000
	Syracuse, N. Y.							
	Halcomb Works	3	6	11–0	Heroult	3,000	..	
		2	3	9–0	Heroult	1,500	..	
	Sanderson Works	2	3	9–0	Heroult	1,500	..	61,000
Driver-Harris Co.	Harrison, N. J.	2	2	7–0	Heroult	....	..	8,000
Empire Ordnance Co.	Philadelphia, Pa.	1	10	12–0	Heroult	7,500	..	24,000
Firth-Sterling Steel Co.	McKeesport, Pa.	2	3	9–0	Heroult	2500; 3000	12	
		2	1½	....	Ajax Induction	....	..	
		1	1	6–3	Heroult	1,500	6	21,000
Henry Disston & Sons, Inc.	Philadelphia, Pa.	1	6	11–0	Heroult	2,500	..	
		1	3	9–0	Heroult	1,500	..	17,000
Heppenstall Co.	Pittsburgh, Pa.	2	1200 lb.	....	Ajax Induction	....	..	2,000
Ingersoll Steel & Disc Co.	New Castle, Ind.	2	3	9–0	Heroult	1,800	..	
		2	5	10–0	Heroult	3,500	..	
		1	1	5–0	Heroult	1,000	..	36,000
Isaacson Iron Works	Seattle, Wash.	2	25	15–0	Lectromelt	9,350	18	90,000
Jessop Steel Co.	Washington, Pa.	3	10	11–0	Lectromelt	5,000	14	
		1	6	11–0	Heroult	4,000	..	
		1	3	9–0	Gronwall-Dixon	2,500	..	67,000
Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	1	1	6–0	Swindell-Dressler	1,000	..	4,500
Joslyn Mfg. & Supply Co.	Fort Wayne, Ind.	1	10	11–0	Lectromelt	5,000	14	
		1	6	11–0	Lectromelt	6,000	..	26,000
Kilby Steel Co.	Anniston, Ala.	1	3	9–0	Lectromelt	2,500	..	
		1	1	....	Lectromelt	500	..	12,000
Knoxville Iron Co.	Knoxville, Tenn.	2	6	9–0	Lectromelt	3,000	..	19,000
Latrobe Electric Steel Co.	Latrobe, Pa.	2	6	11–0	Heroult	3,000 and 1,500	..	
		1	3	9–0	Heroult	1,000	..	
		1	1	5–7	Lectromelt	500	..	26,000
Lebanon Iron & Steel Co.	Lebanon, Pa.	1	3	9–0	Swindell-Dressler	2,500	..	7,200
Mesta Machine Co.	Pittsburgh, Pa.	2	50	17–0	Swindell-Dressler	10,000	18	
		1	15	13–6	Swindell-Dressler	5,000	..	141,000
Midvale Steel Co.	Philadelphia, Pa.	1	50	17–0	Swindell-Dressler	10,000	..	
		1	7½	12–0	Swindell-Dressler	5,000	..	
		1	6	11–0	Swindell-Dressler	2,250	..	90,000
National Forge & Ordnance Co.	Irvine, Pa.	1	10	12–0	Heroult	4,000	..	
		1	6	11–0	Heroult	2,500		

		1	15	13–6	Swindell-Dressler	5,000	..	141,000
Midvale Steel Co.	Philadelphia, Pa.	1	50	17–0	Swindell-Dressler	10,000	..	
		1	7½	12–0	Swindell-Dressler	5,000	..	
		1	6	11–0	Swindell-Dressler	2,250	..	90,000
National Forge & Ordnance Co.	Irvine, Pa.	1	10	12–0	Heroult	4,000	..	
		1	6	11–0	Heroult	2,500	..	
		1	2	7–0	Heroult	1,500	..	30,000
National Supply Co.	Torrance, Cal.	1	15	12–4	Lectromelt	6,000	14	24,000
Northwest Steel Rolling Mills, Inc.	Seattle, Wash.	1	3	9–0	Lectromelt	2,500	..	
		1	6	10–0	Lectromelt	....	..	20,000
Northwestern Steel & Wire Co.	Sterling, Ill.	2	35	17–0	Lectromelt	....	..	100,000
Otis Steel Co.	Cleveland, Ohio	1	2½	7–0	Lectromelt	....	..	6,000
Oregon Electric Steel Rolling Mill	Portland, Ore.	2	10	11–0	Lectromelt	5,000	14	
		1	2	5–8	Lectromelt	800	6	39,000
Pacific States Steel Co.	Oakland, Cal.	3	6	11–0	....	5,000	..	36,000
Pittsburgh Crucible Steel Co.	Midland, Pa.	4	35	15–8; 18–0	Heroult	....	..	216,000
Republic Steel Corp.	Canton, Ohio	5	70	20–0	Heroult	12,000	20	
		6	60	19–0	Heroult	12,000	18 and 20	
		2	40	16–6	Heroult	10,000	18	
		3	15	14–6	Heroult	4,500	14	
		1	6	11–0	Heroult	2,800	12	
		1	6	....	Induction	....	..	983,000
	South Chicago, Ill.	9*	70	20–0	Heroult	12,000	20	650,000
Rotary Electric Steel Corp.	Detroit, Mich.	2	50	18–0	Heroult	12,000 and 10,000	20	130,000
Rustless Iron & Steel Corp.	Baltimore, Md.	1	25	15–8	Heroult	7,500	17	
		2	15	14–6	Heroult	5,000	17	
		3	12	12–6	Heroult	3,500	17	168,000
Sharon Steel Corp.	Lowellville, Ohio	1	15	14–6	Heroult	6,000	..	36,000
Simonds Saw & Steel Co.	Lockport, N. Y.	3	6	11–0	Heroult	(2) 2,500; (1) 1,500	..	
		5	..	....	Ajax Induction	....	..	25,000
Southwest Steel Rolling Mill	Los Angeles, Cal.	1	8	9–10	Lectromelt	3,750	10	10,000
Texas Steel Co.	Fort Worth, Texas	1	3	7–0	Lectromelt	2,000	..	
		1	8	10–0	Lectromelt	3,750	..	18,000
Timken Roller Bearing Co.	Canton, Ohio	1	85	20 × 29	Heroult	2 × 7,500	(6) 18	
		1	70	20–0	Heroult	12,000	18	
		1	60	19–0	Heroult	12,000	18	
		2	40	16–6	Heroult	10,000	18	
		1	20	14–8	Heroult	7,500	17	365,000
Union Electric Steel Corp.	Carnegie, Pa.	2	6	11–0	Swindell-Dressler	1,200 and 1,500	..	19,200
Universal Cyclops Steel Corp.	Bridgeville, Pa.	2	12	11–0	Heroult	3,000 and 4,000	17	
		1	6	11–0	Lectromelt	5,000	14	
		1	3	9–0	Heroult	2,000	9	75,000
Vanadium Alloys Steel Co.	Latrobe, Pa.	2	3	9–0	Heroult	2,500 and 1,500	..	
		1	½	....	Ajax Induction	....	..	12,000
Vulcan Crucible Steel Co.	Aliquippa, Pa.	2	3	9–0	Heroult	2,000 and 1,200	..	12,000
Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	1*	60	18–0	Heroult	12,000	18	
		1*	35	15–8; 18–0	Heroult	10,000	18	115,000
Total	.....	229	..	....	.....	....	..	6,011,100
* Under construction	.....	17	..	....	.....	....	..	1,087,000
		212	..	....	.....	....	..	4,924,100

Estimated costs of producing sponge iron range from an optimistic four dollars a ton to a high of $30. However, as mentioned in the press throughout the past year, the Bureau of Mines is proceeding with experimentation along this line, under a $600,000 grant from Congress. Several plans for direct reduction of iron ore have been brought forward.

The simplification of standard steel specifications, mentioned in this review last year, has been further revised during 1942. The changes have made greater use of residual alloys, which have increased greatly in the past few years. A larger number of alloys have been written into the new list, which contains 18 basic compositions in 47 specifications. Designed basically to reduce our consumption of the strategic alloys, the new NE specifications are definitely "leaner," but have shown up well in application.

Accelerated by the shortage of the various alloying elements, the use of boron has received considerable attention. It has been found that the presence of boron, in amount of .001-.002 per cent, increases the hardenability of steel, prevents ferrite separation while tempering, and increases toughness. As little as .0006 per cent is said to show definite results on hardenability. It is said that .002 per cent of boron is equivalent in action to .35 per cent chromium or .25 per cent molybdenum. A maximum of .003 per cent should not be exceeded if trouble in hot working is to be avoided.

To be effective, boron must be uniformly distributed throughout the metal, and it must be protected from oxidation by the steel. Because of this, it is usually added as ferro-boron, containing 10-20 per cent boron, with a little carbon, some silicon and perhaps some aluminum, or as an alloy containing .5-2.0 per cent boron with substantial amounts of titanium, silicon, aluminum and perhaps manganese or vanadium.

The year has been an unprecedented one in the construction of arc furnaces. This has been one of our more serious bottle-necks, but the situation is rapidly improving. The accompanying list of electric furnaces shows a total of 229 units, with an estimated capacity of about 6,011,100 tons per year. This is comparable to 177 units and an annual capacity of 3,695,000 tons a year ago. Of this year's list, 17 furnaces totaling about one million tons per year capacity, are, at the turn of the year, under construction, but will come into production largely within the first half of 1943. It is interesting to note that the new units are, for the most part, large units, of 50-70 tons nominal capacity.

Production of electric furnace steel for the first nine months of 1942 exceeded the entire 1941 production. The total 1942 production will approximate 4 million tons of ingots.

Recognizing the necessity of using inferior, light scrap, one manufacturer of electric furnaces has modified the design of their smaller sizes, lengthening the side plates in order to increase volumetric scrap capacity and maintain rated size of heats. In the ten ton size, side walls were deepened to allow an increase of 25 per cent by volume in scrap capacity, while the two and five ton sizes were increased about 22 per cent. The furnaces are cylindrical in shape, with spheroidal bottoms.

Air circuit breakers with specially designed interrupters have been used in a number of recent arc furnace installations, thus removing the objection of contaminated oil resulting in the oil type breaker from the very frequent operations in such service.

Arc furnace control is faster, more sensitive, and reliable. One system advanced for electrode control is basically a Ward-Leonard system, with each electrode motor (separately excited) being driven from its own individual generator. The control field of the generator is fed by a balanced system in which the electrode current is balanced against the arc voltage. Any change unbalances this system and forces current through the control field, which immediately produces a voltage to rotate the electrode motor and restore the balanced condition. Thus, operation is smooth and speedy, with electrode speed dependent upon the amount of current unbalance. The use of contactors and relays has been eliminated in this control system. The use of arc voltage as a reference voltage prevents false operations, and the high speed and sensitivity of the control give improved operation, with stable operation at very low arc current values as well as at maximum values.

In some plants, the production of the electric furnaces has been increased materially by duplexing in one way or another, and the success of the process has been such that many other plants are adopting the idea. One com-

Figure 7 — The use of higher iron charges and of inferior grades of scrap are problems continuing to affect the open hearth operator.

pany reports that duplexing from open hearth to electric furnaces doubles the output of electric steel. An entire new electric furnace plant is planned to duplex in conjunction with tilting open hearths. Another plan calls for melting down the pig iron in cupolas, blowing it in a bessemer converter, and then transferring it to the electrics. Still another plant plans to melt steel scrap and pig iron in a cupola and transfer the resultant molten metal direct to the electric furnaces.

Regardless of the method used, a marked increase in electric furnace production will result, as the melt-down period of electric furnace heats is by far the greater part of the total time. Also, the elimination of the heavy melt-down current will ease the demand on power systems, and will reduce total power consumption very materially.

In the open hearth, efforts have been directed toward the problem of using high iron charges, and some progress has been reported, with several plants stating that they are able to use 70-75 per cent iron on common grades of steel. The average for the industry, however, is now only .593 ton of pig iron per ton of steel as against .557 in 1941. Scrap usage now stands at .496 ton per ton of steel. The higher iron charge naturally requires more charge ore, and it has been estimated that direct reduction of ore in this manner may account for as much as 3,000,000 tons of steel.

The total open hearth production of about 76,600,000 net tons of ingots for the year is a tribute to the operators' skill and ingenuity in overcoming the scrap situation and other difficulties so numerous during the past year.

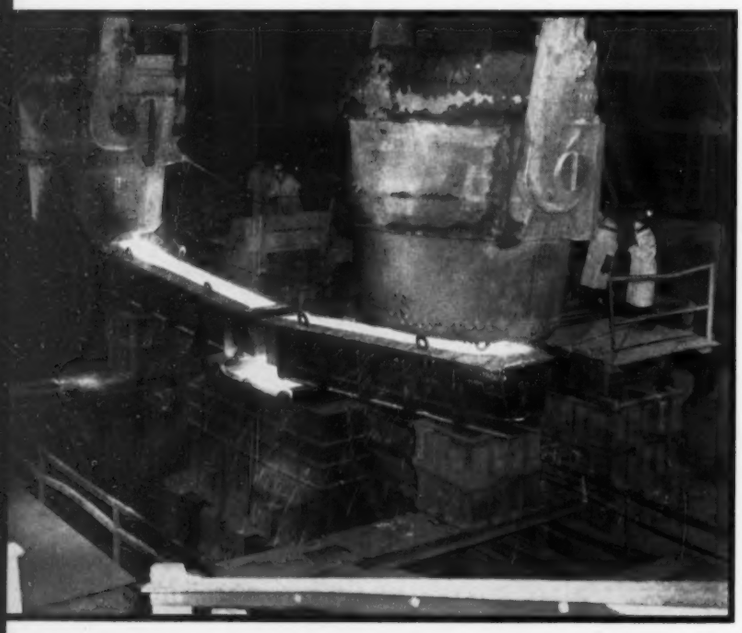
The so-called "rapid metallurgy," whereby high contents of metalloids are reduced, usually by external treatment, continues to receive attention. Much has been published concerning desulphurizing and dephosphorizing by such methods. More recently, one plant has been reducing the silicon in pig iron by treating it with mill scale. In treating 100,000 lb of hot metal of .60 per cent silicon, 2400 lb of scale are used. With .70 per cent silicon, 3000 lb of scale are required. The scale is introduced into the stream of hot metal as it is poured from ladle to ladle. The silicon is said to be reduced to about .40 per cent, and it is reported that 7-10 per cent more iron can therefore be used in the open hearth charge.

Further investigation into the allowable tin content in steel has shown that deep drawing stock must carry less than .02 per cent, while ordinary drawing material can take up to .04 per cent.

In the effort to push production to the utmost, many plants have turned to the spectrograph as a means of rapid analysis, thus reducing laboratory delays. Spectrographic analysis, in general, is restricted to the detection and determination of the metallic alloying elements and impurities. The nonmetals, such as carbon and sulphur, and usually phosphorus, cannot be satisfactorily determined by this method. With good technique and adequate experience, a precision of two to three per cent of the amounts being estimated can be obtained, and this holds through a wide range of concentrations. Thus, high concentrations cannot be determined with the same absolute accuracy as low. For this reason, the use of spectrographic methods is usually confined to the determination of elements not exceeding 4-5 per cent in concentration. This, however, covers the range of the ordinary commercial steels.

Intensive study on this subject has resulted in improved methods and procedure, refinements of apparatus, and better control of the numerous variables. Precision and reliability of the analyses have therefore increased, and some plants rely almost entirely on this method of analysis and report entire satisfaction. The process offers the advantage of complete, speedy analysis, and in some cases is credited with saving one-half to one hour on the time of a heat. If this result can be approximated throughout the industry, the use of the spectrograph should be extended as rapidly as possible.

Figure 8 — War production requires much heavy material, sometimes requiring the use of two ladles of steel to form a single ingot.



ROLLING MILLS

The enormously expanded shipbuilding industry, together with armament projects, has set up an unprecedented demand for steel plate. The Maritime Commission set up their requirements at 418,000 tons per month, and it was said that 1,400,000 tons per month would be required for all purposes. In comparison with the 600,000 tons annual capacity of our existing plate mills, this figure seemed impossible of attainment. However, we have shipped 9,736,000 tons of plate in the first 10 months of 1942, with a monthly record of 1,124,118 tons in July. Subsequent months have been somewhat lower because of diversion of steel to other uses, but the years production should be about 12,000,000 tons.

The demand for plate has been met in part by the installation of a number of new plate mills and in part

by the conversion of wide strip mills. Recent months have shown more than half of our production to come from the latter source. An increase in strip production might be expected next year since the manufacture and use of steel cartridge cases have been worked out satisfactorily.

Typical of the conversion of the strip mills to plate production is the work done on one of these modern installations. Equipping the mill to turn out 5/16 inch and ½ inch plate in vastly increased quantities centered around two important steps. First step was the installation of sufficient additional conveyor table facilities to transfer the plate to the shears. Second step was the installation of an effective hot leveling unit for the initial flattening of the plate immediately it left the hot mill line. This unit has been installed at the end of the hot mill line just ahead of the hot mill transfer table, and can be moved into position for leveling or out of position for coiling strip in five minutes.

Hot mill equipment, except for the addition of the new leveler, has not been changed in any respect. Commencing with the furnaces where the steel is heated to a white-hot rolling temperature, the slabs are sent through the four roughing and six finishing stands, in much the same fashion they would be if destined to be made into strip instead of plate.

The change in handling procedure for plate as compared to strip really commences as the hot steel emerges from the last finishing stand. Strip at this point is passed through a spray of water on a long run-out table and then wound into coils or cut into sheets by a flying shear located just beyond the last finishing stand. Plate, on the other hand, is sent on through the new hot roller leveler and onto the hot bed transfer, where it is checked for gauge and then moved into the new plate mill processing line.

In enlarging the existing plate production facilities, several pieces of equipment, including a roller leveler, side-trimming shear, up-cut shear, side piler and gauge, which had been part of the original ½ inch plate mill line, were relocated to better advantage in a new ½ inch plate line housed in a new bay added to the main mill building.

A second line, parallel to the relocated ½ inch line, handles lighter plate up to ½ inch.

Two adjoining transfer tables, capable of handling plate up to 53 feet in length, were installed to receive plate from the hot mill transfer table over a long filler table equipped with up-cut shear and side piler as well as a pinch roll.

The pinch roll has been installed at the entry to the first section of the new transfer tables to control the feeding of the steel. A cascade arrangement has been successfully worked out which permits the accumulation by pusher cranes of a number of plates at the entry to each of the two plate lines. Lighter plate is taken off at the first cascade and heavier plate at the second.

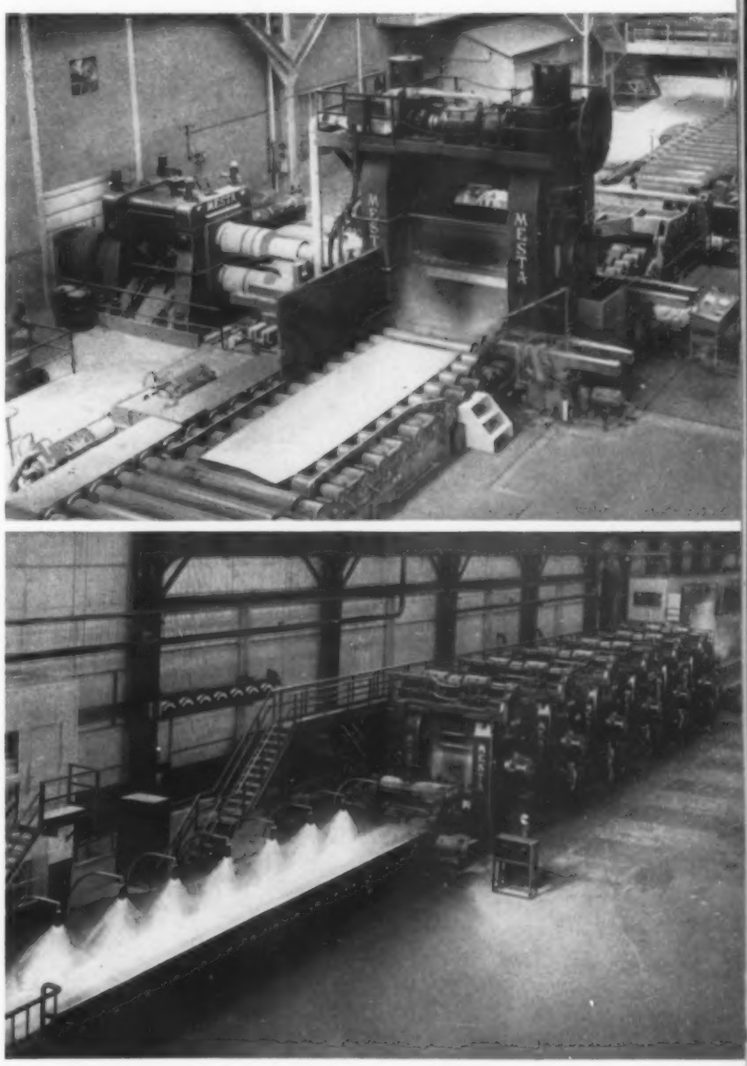
In designing the plate processing lines mechanical handling has been provided wherever possible. Both lines are equipped with magnetic depilers, skew tables, and roller conveyor sections. Overhead cranes, serving all sections of the department, have reduced human exertion in the handling of the plate to a minimum, while at the same time providing additional safety for the operators.

This mill set a record in October, when 85,597 tons of plates were produced. Total production for that month was 111,790 net tons in 83½ turns, for an average rate of 167 tons per hr.

During the first half of the year a 140 in. single stand four-high reversing plate mill was put into service at a southern steel plant. The single armature direct current reversing motor driving this mill is one of the largest machines ever built, rated 7000 hp, 35/70 rpm, 700 volts, and with maximum emergency torque capacity of 2,890,000 lb-ft. Power for the reversing motor is supplied by a flywheel motor generator set consisting of two 3000 kw, 700 volt, compound wound, direct current generators; 6000 hp, 6600 volt, 3 phase, 60 cycle, 352 rpm, wound rotor induction motor; and 154,000 pound steel plate flywheel. The reversing motor and flywheel motor generator set are ventilated by a downdraft air cooling and recirculating ventilation system.

At a Pennsylvania steel plant there is under construction a 120 in. wide single stand four-high reversing uni-

Figure 9 — The demand for plate material continues at an all-time high, resulting in construction of new plate mills and further conversion of wide strip mills.



versal plate mill, intended to operate as a finishing unit in tandem with an existing three-high roughing stand. The main horizontal roll motor is rated 7000 hp, 35/80 rpm, 700 volts, 2,890,000 lb-ft maximum torque capacity, (duplicate of the one described in the preceding paragraph), and the vertical edging roll motor is rated 500 hp, 200/500 rpm, 700 volts, 36,000 lb-ft maximum torque capacity. The flywheel motor generator set consists of three 2000 kw, 700 volt, generators; 6000 hp, 13,200 volt, 3 phase, 60 cycle, 505 rpm, wound rotor induction motor; and 85,000 pound steel plate flywheel.

Building the motor generator set with three 2000 kw generators rather than the usual two 3000 kw generators, permits its operation at 505 rpm rather than 352 rpm, thus requiring smaller machines with consequent saving in copper, steel, and other strategic materials. The flywheel alone will be nearly 35 tons lighter than on the usual 352 rpm set, although providing the same stored energy capacity.

This installation will make use of a unique system of downdraft ventilation, in which outside air is cleaned by passing through a precipitron electrostatic air cleaner and then blown into the motor room by a group of intake fans. The electrical machines are arranged to take their ventilating air from the room, and to discharge the heated air down through the foundations, where individual exhaust fans are provided to exhaust the heated air outside of the motor room. The combination of intake and exhaust fans enables the room to be maintained at pressure above atmospheric to prevent the infiltration of dirt, and the downdraft flow of air assures most of the advantages of a cooling and recirculating system in a location where lack of cooling water prevents the use of the recirculating system.

At another Pennsylvania plant, the capacity for heavy plate production will be very greatly increased by the installation of a 45 in. universal slabbing mill and 160 in. plate mill. The drive for the slabbing mill consists of a 10,000 hp, 40/80 rpm motor for the vertical edging rolls, both supplied with power from a 10,500 kw flywheel motor generator set. A duplicate 10,000 hp, 40/80 rpm, twin-motor drive, consisting of two 5000 hp single armature reversing motors, will be used for the drive of the 160 in. wide four-high reversing plate mill. Twin-motor drives have been applied to five large slabbing and blooming mills, however this will be the first installation on a plate mill. The installation also represents the greatest power ever applied to a reversing plate mill.

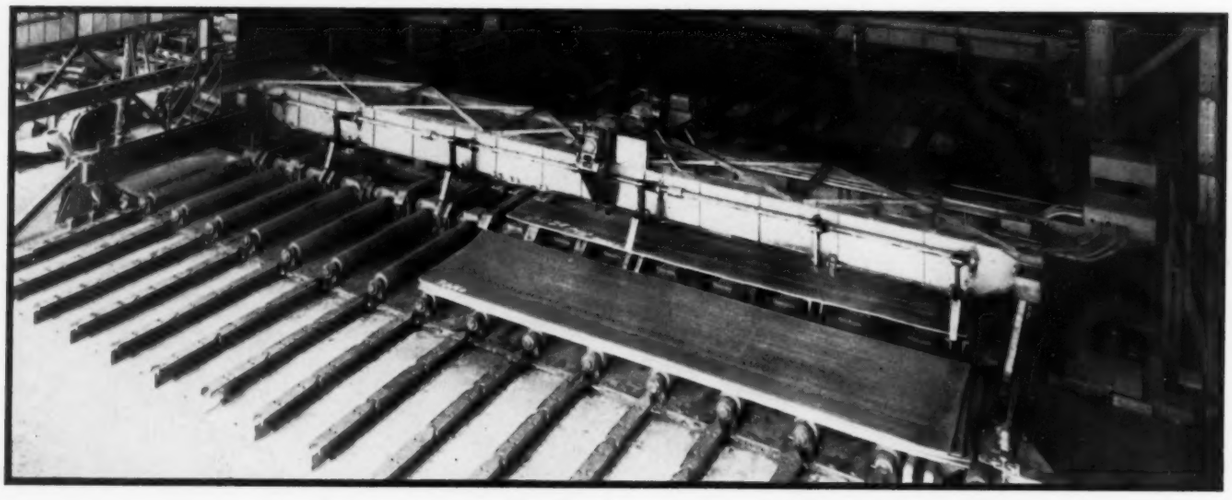
A 132 in. wide eight-stand semi-continuous plate mill is now under construction at a western steel plant. The multiple stand continuous arrangement of the mill assures very large output of all types of plate, and extensive leveling, trimming, shearing, and finishing facilities are essential to expeditiously handle this large tonnage of diversified sizes and shapes of plate.

A radical innovation in the design of rolling mill motors is incorporated in a 7000 hp, 25-60 rpm reversing motor built for the roughing stand of this semi-continuous mill. Although stated to be the largest motor ever built, both from a physical and a torque standpoint, it has no through shaft. The motor is 44 ft long, 18 ft wide and 16 ft high, and weighs 1,000,000 lb. Shaft extensions, 36 in. in diameter and designed for a torque of 1,470,000 lb-ft continuously, 4,100,000 lb-ft momentarily, are bolted on to the motor armatures, and the two armatures are bolted together through large flanges.

While plate mills have formed the bulk of activity in the rolling mill field, several new blooming and slabbing mills are under construction as well as several rod mills for both steel and aluminum. A novel tube mill is being built in which the 16 adjustable speed individual drive motors are designed so as to reduce to a minimum the impact speed drop and subsequent ballooning due to recovery of speed. The mill stands in this installation are spaced on 12½ in. centers.

Studies into the operating cycles of reversing blooming and slabbing mills have shown that shorter reversing times are feasible without shock to the machinery when current peaks are eliminated. Such operation, with smooth acceleration and deceleration, is obtained through the use of amplifying exciter control. In this method, large contactors carrying heavy current are replaced with relays carrying very small currents, and a greatly reduced number of control devices are re-

Figure 10 — In converting the strip mills to plate production, most of the changes center in the runout end and involve handling and shearing equipment.



ired. Effective load-limit control, allowing the motor to put out a maximum at all times with full protection, has improved production, and a higher average speed results from improved voltage maintenance. Reversing times can be set to minimum values as limited by manipulation of the ingot and screw-down settings. A considerable number of reversing mill drives are being equipped with control systems of this type.

In many cases it has been possible to increase the output of a mill without disturbing foundations or mechanical arrangement. The rebuilding of an old drive motor or the installation of a new motor often removes a bottle-neck and brings about a material increase in production.

It has been possible to increase the capacity of old electric drives by as much as 40 per cent. The greater capacity was obtained by designing new armatures using deeper slots and larger copper straps in the winding. To utilize this increase completely, it is necessary to provide more flux in the commutating zone.

Similarly, auxiliary drives of old design may be rewound so as to increase their capacity materially. Many cases prove the worth of new control equipment to replace equipment of obsolete design, showing marked increases in production with less maintenance and lost time.

PROCESSING AND FINISHING

Throughout the industry, facilities for the processing and finishing of armor plate have expanded by leaps and bounds. The principal tank hull parts, consisting of more than thirty pieces, are heat treated, cut, and made ready for final assembly. Such installations include many heat treating furnaces, quenching tanks, abrasive plate cleaners, roller leveler units, oxy-acetylene shape cutting machines, flame treating machines, straightening presses, handling equipment, etc., setting up great activity in those lines.

During the past year, electrolytic tinning has perhaps received more publicity than any other single steel plant development. This is no doubt because of the fact that tinplate — in its ultimate form, the can — enters to such an extent into our everyday life. To stretch our materially reduced tin supply to fulfill our requirements, it became necessary to plan for an annual capacity of about 1,400,000 tons of electrolytic tinplate. The various producers therefore have 27 new electrolytic tinning lines built and building, which, with the half-dozen original installations in which the process was developed, will meet this requirement.

The various units differ somewhat as to their mechanical design and the type of electrolytic bath used. Each complete unit consists essentially of uncoilers, crop shear, lap seam or spot welder, pinch rolls, looping device or pit, plating tanks, reflow unit, branner, tension unit, another looping device or pit, and a flying shear and classifying unit. These items of equipment may be installed as one continuous processing unit, or they may be split up into as many as three separate lines, one applying the coating, a second acting only as a reflow line, and the third being a conventional shearing line. Opinion seems to favor the consolidated line, which eliminates considerable recoiling and handling.

In some cases, still other units are added in tandem in order to further reduce the number of operations.

In a new installation nearing the production stage the strip enters the tinning line from one or the other of two uncoilers which are used alternately. The operation of the line is expected to be such that when a new coil is stitched or welded on to the trailing end of a preceding coil, the line is first slowed down to a point which represents the highest speed (in the neighborhood of 75 to 100 fpm) that can be maintained and still have the weld completed before the entire storage is removed from the loop.

In addition to the two uncoilers, the line includes the following units: seam welder, loop pit, roller guide, pin

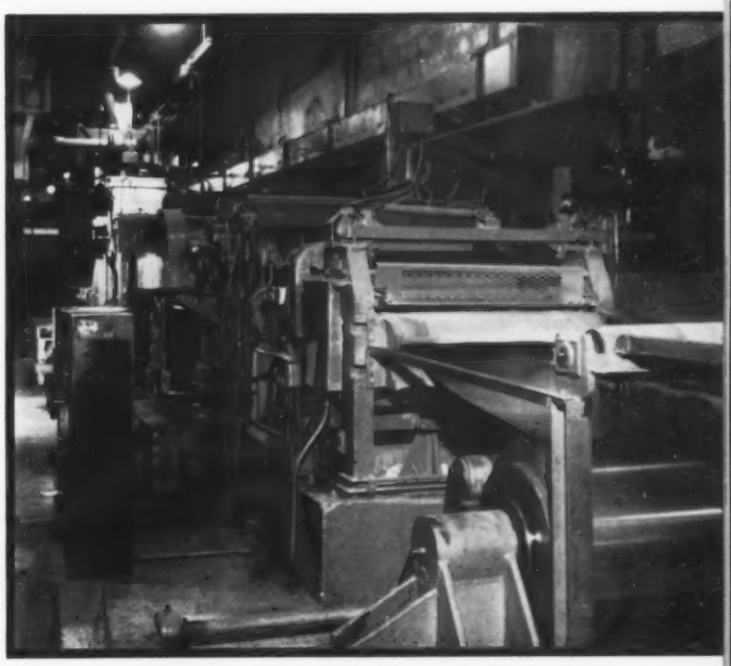


Figure 11 — Twenty-seven electrolytic tinning lines, now in various stages of completion, will enable us to stretch our reduced tin supply to cover essential tinplate requirements.

hole detector, gauge rolls and marker, drag bridle rolls, electrolytic pickler, brushing machine, four-compartment plating tank, recovery system of sprays and rolls, ten-roll wire brush machine, steam dryer, reflow unit, drive bridle, weld cutout shear, roller leveler, flying shear, off-weight piler, branner, and final piler.

The line operates in synchronism over a 24:1 speed range by combined variable voltage and field control. The main drive bridle is the master motor and its speed is under the control of a speed regulator operating on a motor-operated rheostat and itself having a vernier speed control. The center portion of the line between the entry drag bridle and the main drive bridle has the strip under tension. The tension at the entry drag bridle is under the control of a tension regulator. Since the speed range of the line is partially by voltage and partially by field control, this tension regulator for the entry drag bridle operates on a small booster, so that

Figure 12 — D-c power at 17,000 volts is converted to 200,000 cycle a-c power in this 100 kw vacuum oscillator which supplies power for tin reflowing by induction heating.

irrespective of whether the line is operating on voltage control or field control, current in the armature of the entry drag bridle will indicate the same back tension.

The motor-operated rheostat which controls the speed of the main drive bridle by voltage and field actually controls the voltage of the generator to give voltage control and controls also the counter emf exciter will control the field strength to the main drive bridle, the entry pinch roll, the flying shear motor and the lapping conveyor motors.

The matching of the entry pinch roll motor field with the main drive bridle motor field is important since this entry pinch roll must be able to over-speed the rest of the line to accumulate a loop in the pit. The tension between the uncoiler drag unit and the entry pinch roll is only of sufficient magnitude to prevent the coil from unwinding and to assist in decelerating the coil when the line is decelerated. Tension as such and the accuracy of tension is inconsequential at this point. However, tension regulators are being used to avoid the use of rider roll rheostats and to relieve the operator of any particular attention at this point. Each of these uncoiler drag units will pump into its own generator whose field will be changed in proportion to the line speed.

The branner drive and the two conveyors immediately preceding it are on their own separate generator. This is done since the action of a branner may not be satisfactory at very low speeds. The branner will actually run over a speed range of much narrower proportions than is true of the rest of the line.

The modern lines have been designed for strip speeds of 500-650 fpm, and a speed of 1000 fpm is predicted in the near future. Accurate synchronization of the many drives in an installation of this type presented many problems which have been worked out by ingenious correlation of drives and controls.

Plating baths may be alkaline or acid in nature, or a combination of the two. Alkaline baths, such as a sodium stannate solution, etc., gives a smooth, adherent coating, but use more power than the acid baths. Proper control of the free caustic soda content of alkaline baths is essential. Acid baths, however, containing stannous sulphate, sulphonated hydrocarbons, etc., with additions of glue, cresol or other tar distillation product, seem to be preferred in the majority of the processes. Bath temperatures are usually automatically controlled, usually running about 170 F for alkaline baths and 100 F for acid baths. Current densities range up as high as 200 amp per sq ft.

Current for the electrolytic bath, running perhaps 60,000 amp at 6-12 volts may be supplied from low voltage generators. Because the amount of plating put on the strip is dependent upon time and current, an accurate current control system was developed which maintains current density approximately proportionate to speed. A special instrument is used to control a motor-operated rheostat in the field of the plating exciter. The instrument has a bridged circuit in connection with a tachometer driven by the main drive bridle and a plating current shunt to obtain an inter-relationship of plating current and speed. The current value for any given speed can be adjusted to compensate for the desired coating thickness and for strip width.

Rectifiers, either of the selenium or copper oxide type, are also applied as current source for the plating bath. Rectifiers offer the advantages of low maintenance, small floor space, low installation cost and flexible operation. For a 9 volt installation, the cost of rectifiers and motor generator set are about equal. At 6 volts, the rectifier has a definite advantage, while at 12 volts, the advantage is in favor of the motor generator set, although this advantage may be offset by the difference in maintenance.

Applications of selenium type rectifiers use a saturable core reactor on each bank for voltage control over a 20:1 range. Each bank also has its own motor-driven blower for air circulation, and is equipped with thermal guards which operate warning lights. Rectifier plates are immersed in transformer oil and arranged in racks in a sheet metal enclosure.

The tinplate produced electrolytically has a gray matte surface, rather porous in structure. To improve the appearance and resistance to corrosion, some form of "reflowing" is generally desired. Numerous methods have been advanced to effect this, including brushing with tampico brushes to a satin finish, skin passing between heated rolls, heating the tinned strip in a hot oil bath or in electric or radiant tube furnaces, or heating the strip by conduction or induction.

Conduction or induction heating seems to be preferred in the newer high speed lines as these methods require relatively little space and can be accurately controlled. The induction method seems to have several advantages, entailing no problem of getting power into the strip at high speeds, and having no parts in contact

with the strip. The inductor heating coil is rectangular in form, wound as close to the strip as mechanically possible. It acts as the primary of a transformer, while the strip itself constitutes a single turn secondary in which the induced current generates the desired heat.

For usual tinplate gauges (.008-.011 in.) a frequency of about 200,000 cycles per sec seems most practical. As rotating machinery is not practical above 15,000 cycles per sec, power is supplied by vacuum tube oscillators which are essentially the same as the transmitter of a radio station. Sixty cycle alternating current is rectified to direct current and fed to the oscillator tubes where it is converted to the high frequency and sent out through the inductor heater coil. Power input may be rapidly adjusted to accommodate changes in strip speed. Based on a strip speed of 1000 fpm, an oscillator of 1200 kw output is required, which requires about 2300 kw of power input. The process is extremely rapid, requiring only 10-12 ft length of inductor coil for strip speeds up to 1000 fpm. This type of reflowing has been applied to one commercial tinning line, and a number of additional units are under construction.

A number of substitutions for tin plate have been advanced, with bonderizing apparently in the lead. The bonderized film alone is not corrosion resistant, but must be lacquered. It appears to meet the requirements of temporary rust resistance, eliminate underfilm corrosion and provide good lacquer adhesion. Approximately 20 lines of this type are being installed. Other surface films may be produced by chemical treatment, of phosphate, chromate or borate types.

FUELS AND FURNACES

In a round-table discussion on steel plant fuel supplies held by the Combustion Division at the A. I. S. E. annual meeting, it was brought out that the construction of new coke ovens and blast furnaces has altered the fuel situation in several plants, reducing the amount of purchased fuel and requiring the changing of some fuel-consuming units over to the added by-product fuels.

In the southern and mid-western districts, a considerable amount of natural gas is used, although some units have been converted from natural gas to producer gas or oil. A shortage of fuel oil in the mid-west section would entail increased use of producer gas or natural gas. A number of plants are preparing old gas producers for such eventualities. In the south, natural gas is used in preference to oil because of price relation.

Eastern plants, formerly supplied with fuel oil from tankers, are now dependent on railroad tank car shipments, creating quite a transportation problem. In some cases, the export of steel in semi-finished form has curtailed finishing mill operations materially, thereby reducing purchased fuel somewhat.

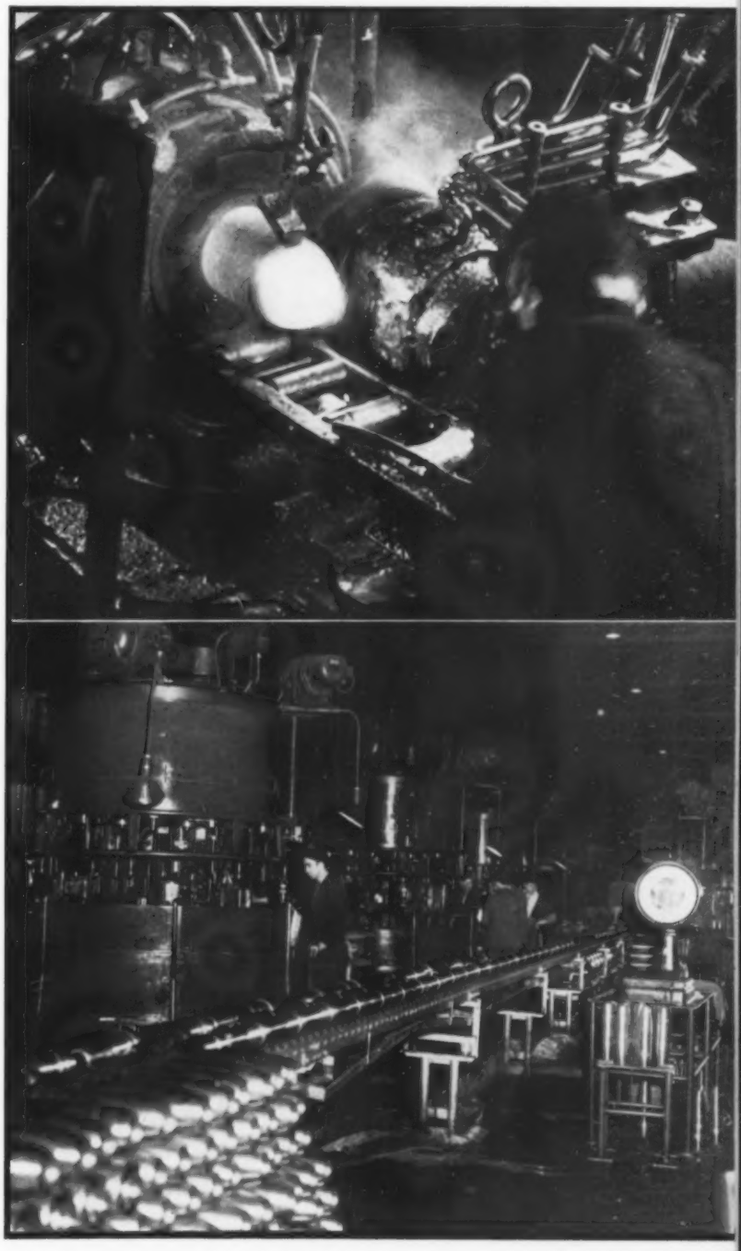
Producer gas will probably be the substitute for fuel oil should the supply of the latter be further decreased, although it is the general opinion that open hearth production is reduced by such a change, while fuel consumption and furnace rebuilding increase.

The fuel shortage in the eastern sections has led to consideration of shutting down steel plant power plants and purchasing power from the utility companies, thus freeing blast furnace gas for metallurgical heating processes.

Tar is on the decrease as a fuel, although the use of pitch has increased. One plant is using a 50 per cent residual from tar, which is cut with fuel oil in the tanks just before pumping.

The character of fuel oil has changed, running .92-.93 specific gravity instead of the customary unity. One report shows a drop from 9 or 10 degrees Baume to 15-17, with a present heating value of about 145,000

Figure 13 — The production of shells, bombs, and other materials of war is constantly increasing in American steel plants. Typical of the ingenuity applied is the new bomb spinning process.



Btu per gal. Fuel oil now contains more gasoline, thus increasing the amount of oil available. In some cases, fuel oil in storage was purposely cut down in the tanks. The greater output of high octane gasoline also contributes to the lighter fuel oil. Liquid fuel must now be shipped by truck for hauls less than 200 miles.

The discussion also touched on the possibilities of pulverized coal, which has been applied to a number of forge furnaces. It was also stated that pulverized coal can be successfully burned in the tubes of radiant tube furnaces.

Also mentioned was the very regrettable bleeding of gas which is occurring in certain districts.

There has been considerable activity in the rehabilitation of old continuous heating furnaces, resulting in marked increased in production with reduced fuel consumption per ton of steel heated. The time and materials required to remodel a furnace are not great. Changes may include raising the roof to obtain greater combustion volume, installing burners to fire under the steel, and in some cases, removing water-cooled skids and putting in a solid hearth furnace. The installation of modern burner equipment of the proper capacity and of control equipment has also shown improved results. It is generally recognized that steel can absorb heat considerably faster than was previously believed, and by thus equipping an old furnace to effectively release more heat, a material increase in furnace capacity may usually be obtained, as well as an improvement in the heating itself.

The tremendous increase in ship plate and armor plate production has brought the long-neglected side-door, in-and-out furnace into prominence. One new design of this type is fired from both ends, through a simple adjustable fuel pipe and a port. Waste gases are exhausted through the hearth at the center of the furnace, and pass on to recuperators placed directly underneath the furnace. Air for combustion is delivered to the ports at 1500 F preheat, promoting rapid combustion and holding end sections of the furnace up to temperature. The elimination of door jambs through the use of a continuous door system gives 20-25 per cent greater capacity than in conventional side-door furnaces, and permits charging very large ingots or blooms.

The standard cylindrical bell type furnace has been easily adapted to the spheroidizing of bullet core rod, airplane and tank bolt stock, wire for airplanes and for naval cable armoring, strip for machine gun and cannon clips, etc. Bell type annealing furnaces have also been adapted to long bars and tubes up to 31 ft in length.

Another type of furnace developed because of the armament program is a vertical continuous gun barrel furnace for normalizing, hardening and drawing, giving high production from very small floor space.

Large shells (3-8 in.) are heat treated in continuous pusher type roller rail furnaces at a rate of 40-200 pieces per hr. The furnaces are built to handle two to twelve rows of shells, and performs the hardening, quenching and drawing operations in continuous sequence. The shells move through the furnace under action of a pusher which can be adjusted and synchronized with the quench system.

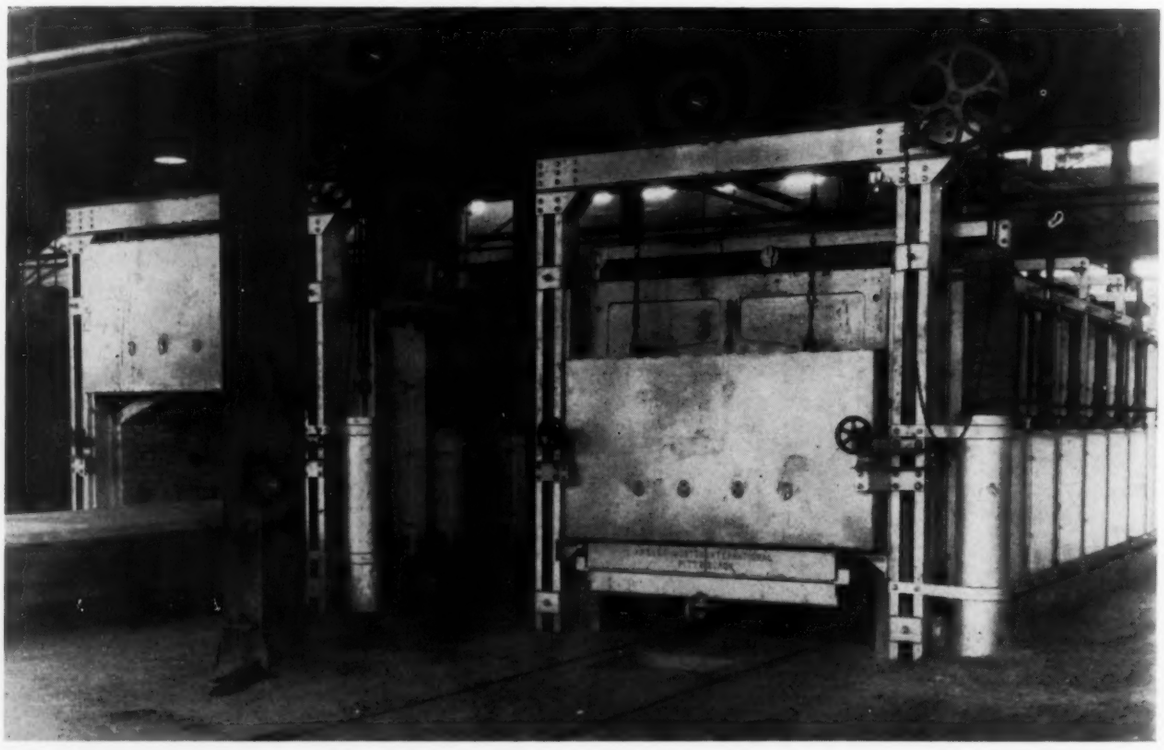


Figure 14 — Car-type furnaces of this design are widely used for annealing gun forgings and armor plate.

As the shell enters the quench oil, it is stopped momentarily under the surface and jets of oil under pressure are forced into the cavity. The shells are then automatically carried from the quench to the apron of the draw furnace and on to the conveyor.

The hardening furnace is direct fired, top and bottom, from both sides, while the draw furnace is heated by convection, the hot gases being circulated through the furnace, drawn off for reheating and then recirculated.

Current demands for more and more production frequently impose increasingly severe conditions upon refractories. The development of improved silica brick promises improved service for open hearth roof construction, and test data indicate the possibility of somewhat higher furnace temperatures with this brick. Likewise, improved fireclay brick, hard burned, has shown its ability to withstand severe conditions in soaking pits and heating furnaces. High alumina bricks are commercially available in 50, 60, 70, 80 and 90 per cent alumina classes, with their refractoriness increasing approximately in proportion to their alumina content, and a substantial percentage of corundum particularly adapts them to heavy loads in high temperature applications.

ELECTRICAL DEVELOPMENTS

The widespread construction of armament plants, the general expansion of the metal industries, and the many new electric furnace installations previously mentioned have combined to raise transformer manufacture to high levels of activity. Some improvements are to be noted in transformer construction, as well as some changes in a number of cases dictated by a shortage of critical material.

Two unusually large units were built to step up power from 27,000 volts to 132,000 volts for transmission to a new aluminum expansion. Weighing 257 tons each, these units are 25 ft high, 39 ft long and 24 ft wide. Through the use of a new core steel, which carries one-third more magnetic flux than steels formerly used, a considerable reduction in size and copper winding was affected.

An unusual feature in transformer construction is to be noted at one of the aluminum plants of Defense Plant Corporation, where a silver-wound transformer is to be installed with silver bus-bars. For this job, 13,000 tons of silver, valued at $200,000,000 was loaned by the United States Treasury from the vaults at West Point. The silver will be fabricated by copper companies and shipped to the plant ready for use. At the end of the emergency, it will be returned to the Treasury. Additional use of silver at the government financed aluminum plants will bring the total for 1942 up to about 20,000 tons, and 26,000 tons more are planned on for 1943.

The capacity of transformers already in service may be increased by 20 to 60 per cent with a new system of forced-oil cooling, while new transformers may be made smaller, with consequent saving of materials. The new cooling unit is compact, factory-assembled, and consists of a radiator-type cooler and a special pump with motor enclosed. These are connected by piping to the standard radiator valves at the side of the transformer. No stuffing boxes are used in the special pump, and the motor is self-cooled and self-lubricated. Use of the system will protect overloaded transformers and may avoid the necessity of new transformer units.

The loading of transformers according to copper temperature has also given increased capacity in many cases. Sustained overloads of 15-25 per cent may thus be carried, and peak overloads up to 50-100 per cent, depending on the duration of the overload.

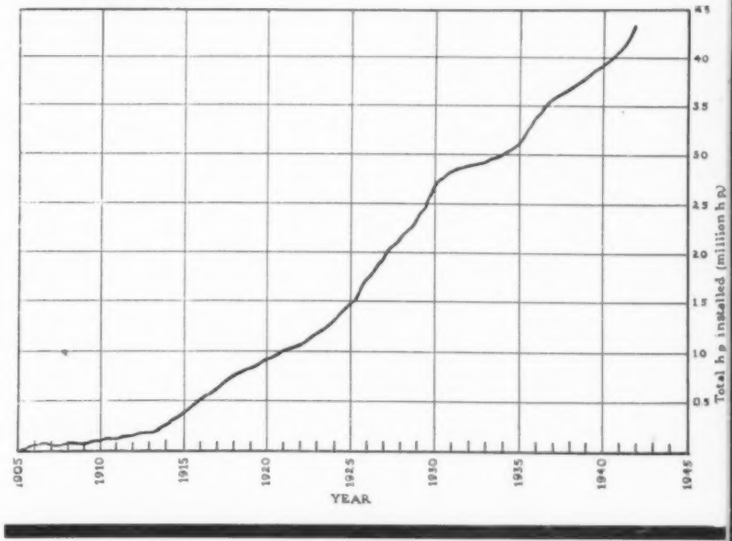
The accompanying main drive motor list shows 111 new motors for the year, totaling 283,650 hp. This is in comparison with 1941, when 123 units totaled only 144,450 hp. An inspection of the 1942 tabulations shows a considerable number of large motors, accounting for the high average of 2550 hp per unit as against an overall average of about 1500 hp per unit. The installations during the past year include a number of heavy mill units, quite a few of which are in new aluminum plants. These plants, to a great extent, use the same type of mill equipment as the steel industry, and the tremendous expansion in aluminum accounts for a goodly portion of the equipment business.

Activity in the small motor field has been even more intense than in the larger units. In order to ease the situation in regard to electric motors, certain recommendations have been made by WPB, urging the use where possible, of open type motors of single, high speed. Single windings and single voltages are also recommended, as well as a-c instead of d-c, and squirrel cage instead of slip ring. Likewise, care in determining motor size and the use of motors on the small side are urged.

Similar recommendations have been made in regard to control and distribution equipment, all tending to reduce the consumption of critical materials and to simplify and standardize the equipment.

There seems to be a considerable stock of second-hand motors available throughout the country, and their use

Figure 15 — The cumulative curve of main drive motors over 300 hp shows a present total of 4,329,315 hp. One hundred and eleven motors (283,650 hp) were added in 1942.



ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER

APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING 1942

Item	Horse-power	Revolutions per minute	Volts	Frequency	Method of drive	Kind of mill	Purchaser	Location	Manufacturer
1	300	300/1350	600	d-c.	Geared	Tandem cold strip reel	National Steel Co. of Brazil	Volta Redonda, Brazil	General Electric
2	300	150/300	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
3	400	200/400	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
4	400	200/400	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
5	400	125/500	750	d-c.	Geared	Edger, aluminum mill	Aluminum Company of America	Trentwood, Washington	General Electric
6	500	200/400	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
7	500	225/450	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
8	500	300/950	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
9	500	150/600	600	d-c.	Geared	No. 2 scalebreaker	Columbia Steel Company	Provo, Utah	General Electric
10	500	300/500	250	d-c.	Geared	Delivery tension roll	National Steel Company of Brazil	Volta Redonda, Brazil	Allis-Chalmers
11	500	300/500	250	d-c.	Geared	Temper pass mill	National Steel Company of Brazil	Volta Redonda, Brazil	Allis-Chalmers
12	500	514	2300	60①	Geared	Sizing mill	Globe Steel Company	Milwaukee, Wisconsin	Allis-Chalmers
13	500	514	2300	60①	Geared	Sizing mill	Globe Steel Company	Milwaukee, Wisconsin	Allis-Chalmers
14	500	200/500	700	d-c.	Geared	Plate mill edger	Lukens Steel Company	Coatesville, Pennsylvania	Westinghouse
15	600	300/600	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
16	600	300/600	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
17	600	125/405	700	d-c.	Geared	Universal plate mill edger	National Steel Company of Brazil	Volta Redonda, Brazil	Westinghouse
18	600	225/760	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
19	600	225/787	600	d-c.	Geared	Cold strip mill	U. S. Treasury Dept., Procurement	Russia	General Electric
20	600	225/787	600	d-c.	Geared	Cold strip mill	U. S. Treasury Dept., Procurement	Russia	General Electric
21	600	225/787	600	d-c.	Geared	Cold strip mill	U. S. Treasury Dept., Procurement	Russia	General Electric
22	600	225/787	600	d-c.	Geared	Cold Strip mill	U. S. Treasury Dept., Procurement	Russia	General Electric
23	700	300/750	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
24	700	300/750	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
25	700	400/1020	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
26	700	400/1020	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
27	700	400/1020	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
28	750	400/800	750	d-c.	Geared	Tandem cold strip mill	National Steel Company of Brazil	Volta Redonda, Brazil	General Electric
29	800	353	440	60②	Geared	Skin pass mill	Aluminum Company of America	McCook, Illinois	Westinghouse
30	800	353	440	60②	Geared	Skin pass mill	Aluminum Company of America	McCook, Illinois	Westinghouse
31	800	225/600	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
32	800	225/600	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
33	800	300/840	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
34	800	300/840	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
35	800	300/840	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
36	800	360	440	60①	Geared	Hoop mill	Taylor Forge & Pipe Works	Chicago, Illinois	General Electric
37	800	360	2300	60②	Geared	Edger	Columbia Steel Company	Provo, Utah	General Electric
38	800	900	2300	60①	Geared	Sizing mill	Segar Refrigerator Company	Memphis, Tennessee	General Electric
39	900	225/760	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
40	1000	505	6600	60②	Geared	Finishing mill	Aluminum Company of America	Heath, Ohio	Westinghouse
41	1000	505	6600	60②	Geared	Finishing mill	Aluminum Company of America	Heath, Ohio	Westinghouse
42	1000	200/600	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
43	1250	300/700	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, New York	General Electric
44	1250	70/210	600	d-c.	Geared	Plate mill edger	Lukens Steel Company	Coatesville, Pennsylvania	General Electric
45	1250	240	6600	60②	Geared	132 in. plate mill scalebreaker	Columbia Steel Company	Provo, Utah	General Electric
46	1250	353	6600	60②	Geared	Skin pass mill	Aluminum Company of America	Trentwood, Washington	Westinghouse
47	1500	225/450	600	d-c.	Geared	18 in. merchant mill	Kaiser Company	Fontana, California	Westinghouse
48	1500	300/670	600	d-c.	Geared	Rod and merchant mill	Aluminum Company of America	Massena, N. Y.	General Electric
49	1500	150/300	600	d-c.	Geared	Reversing hot breakdown mill	U. S. Treasury, Procurement	Russia	General Electric
50	1500	300/600	750	d-c.	Geared	Tandem cold strip mill	National Steel Company of Brazil	Volta Redonda, Brazil	General Electric
51	1500	300/600	750	d-c.	Geared	Tandem cold strip mill	National Steel Company of Brazil	Volta Redonda, Brazil	General Electric
52	2000	175/350	600	d-c.	Geared	Single stand cold mill	Aluminum Company of America	McCook, Illinois	Allis-Chalmers
53	2000	175/350	600	d-c.	Geared	Single stand cold mill	Aluminum Company of America	McCook, Illinois	Allis-Chalmers
54	2000	175/350	600	d-c.	Geared	Tandem cold mill	Aluminum Company of America	McCook, Illinois	Allis-Chalmers
55	2000	175/350	600	d-c.	Geared	Tandem cold mill	Aluminum Company of America	McCook, Illinois	Allis-Chalmers
56	2150	0/95/190	700	d-c.	Direct	Finishing mill—Rev.	Columbia Steel Company	Provo, Utah	Allis-Chalmers
57	2250	300/600	600	d-c.	Geared	Cold strip mill	U. S. Treasury, Procurement	Russia	General Electric
58	2250	300/600	600	d-c.	Geared	Cold strip mill	U. S. Treasury, Procurement	Russia	General Electric
59	2250	250/550	600	d-c.	Geared	Two stand cold mill	Aluminum Company of America	Trentwood, Washington	General Electric
60	2250	250/550	600	d-c.	Geared	Two stand cold mill	Aluminum Company of America	Trentwood, Washington	General Electric
61	2250	250/550	600	d-c.	Geared	Single stand cold mill	Aluminum Company of America	Trentwood, Washington	General Electric
62	2250	250/550	600	d-c.	Geared	Single stand cold mill	Aluminum Company of America	Trentwood, Washington	General Electric
63	2250	250/550	600	d-c.	Geared	Five-stand hot mill	Aluminum Company of America	Trentwood, Washington	General Electric
64	2500	0/70/140	600	d-c.	Direct	32 in. reversing finishing mill	Republic Steel Corporation	South Chicago, Illinois	Allis-Chalmers
65	2500	225/450	600	d-c.	Geared	Five-stand hot mill	Aluminum Company of America	McCook, Illinois	General Electric
66	2500	250/500	750	d-c.	Geared	Hot strip finishing	National Steel Company of Brazil	Volta Redonda, Brazil	General Electric
67	2500	250/500	750	d-c.	Geared	Hot strip finishing	National Steel Company of Brazil	Volta Redonda, Brazil	General Electric
68	2500	250/500	750	d-c.	Geared	Hot strip finishing	National Steel Company of Brazil	Volta Redonda, Brazil	General Electric
69	3000	392	6600	60②	Geared	Bar mill breakdown	Aluminum Company of America	Heath, Ohio	Westinghouse
70	3000	392	6600	60②	Geared	Bar mill breakdown	Aluminum Company of America	Heath, Ohio	Westinghouse
71	3000	60/180	700	d-c.	Geared	Slabbing mill edger	Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	Westinghouse
72	3500	175/350	600	d-c.	Geared	Five-stand hot mill	Aluminum Company of America	McCook, Illinois	General Electric
73	3500	175/350	600	d-c.	Geared	Five-stand hot mill	Aluminum Company of America	McCook, Illinois	General Electric
74	3500*	30/75	750	d-c.	Direct	Slabbing mill	Kaiser Company	Fontana, California	General Electric
75	3500*	30/75	750	d-c.	Direct	Slabbing mill	Kaiser Company	Fontana, California	General Electric
76	4000	0/50/120	700	d-c.	Direct	Reversing mill	Columbia Steel Company	Provo, Utah	Allis-Chalmers
77	4000	0/80/160	700	d-c.	Direct	Reversing intermediate mill	Columbia Steel Company	Provo, Utah	Allis-Chalmers
78	4000	175/350	600	d-c.	Geared	Five-stand hot mill	Aluminum Company of America	McCook, Illinois	General Electric
79	4000	175/350	600	d-c.	Geared	Five-stand hot mill	Aluminum Company of America	McCook, Illinois	General Electric
80	4000	175-350	600	d-c.	Geared	Five-stand hot mill	Aluminum Company of America	Trentwood, Washington	General Electric
81	4000	175/350	600	d-c.	Geared	Five-stand hot mill	Aluminum Company of America	Trentwood, Washington	General Electric
82	4000	175/350	600	d-c.	Geared	Five-stand hot mill	Aluminum Company of America	Trentwood, Washington	General Electric
83	4000	175/350	600	d-c.	Geared	Five-stand hot mill	Aluminum Company of America	Trentwood, Washington	General Electric
84	4500	150	6600	60②	Geared	Broadside mill	Columbia Steel Company	Provo, Utah	General Electric
85	5000	0/50/120	600	d-c.	Direct	36 in. reversing mill	Republic Steel Corporation	South Chicago, Illinois	Allis-Chalmers
86	5000	0/80/160	600	d-c.	Direct	32 in. reversing intermediate mill	Republic Steel Corporation	South Chicago, Illinois	Allis-Chalmers
87	5000	0/50/120	600	d-c.	Direct	Reversing blooming mill	Aluminum Company of America	Heath, Ohio	Allis-Chalmers
88	5000	50/120	750	d-c.	Direct	36 in. blooming mill	Sheffield Steel Corporation	Houston, Texas	General Electric
89	5000*	40/80	750	d-c.	Direct	Slabbing mill	Columbia Steel Company	Provo, Utah	General Electric
90	5000*	40/80	750	d-c.	Direct	Slabbing mill	Columbia Steel Company	Provo, Utah	General Electric
91	5000	124/245	600	d-c.	Geared	Finishing mill	Columbia Steel Company	Provo, Utah	General Electric
92	5000	125/245	600	d-c.	Geared	Finishing mill	Columbia Steel Company	Provo, Utah	General Electric
93	5000	125/245	600	d-c.	Geared	Finishing mill	Columbia Steel Company	Provo, Utah	General Electric
94	5000	125/245	600	d-c.	Geared	Finishing mill	Columbia Steel Company	Provo, Utah	General Electric
95	5000	40/80	750	d-c.	Direct	Reversing hot mill	Aluminum Company of America	Trentwood, Washington	General Electric
96	5000	30/60	750	d-c.	Direct	Reversing hot mill	Aluminum Company of America	Trentwood, Washington	General Electric
97	5000	70/150	750	d-c.	Direct	Structural finishing mill	Kaiser Company	Fontana, California	General Electric
98	5000	50/120	700	d-c.	Direct	Reversing roughing mill	Kaiser Company	Fontana, California	Westinghouse
99	5000	50/106	700	d-c.	Direct	72 in. Universal plate mill	National Steel Company of Brazil	Volta Redonda, Brazil	Westinghouse
100	5000*	40/80	700	d-c.	Direct	45 in. slabbing mill	Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	Westinghouse
101	5000*	40/80	700	d-c.	Direct	45 in. slabbing mill	Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	Westinghouse
102	5000*	40/80	700	d-c.	Direct	160 in. reversing plate mill	Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	Westinghouse
103	5000*	40/80	700	d-c.	Direct	160 in. reversing plate mill	Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	Westinghouse
104	5000	30/60	525	d-c.	Direct	Reversing plate mill	Aluminum Company of America	McCook, Illinois	Westinghouse
105	5000	30/60	525	d-c.	Direct	Reversing plate mill	Aluminum Company of America	McCook, Illinois	Westinghouse
106	6000	50/120	700	d-c.	Direct	40 in. blooming mill	National Steel Company of Brazil	Volta Redonda, Brazil	Westinghouse
107	7000	0/40/100	600	d-c.	Direct	44 in. blooming mill	Republic Steel Corporation	South Chicago, Illinois	Allis-Chalmers
108	7000	50/100	750	d-c.	Direct	Blooming mill	U. S. Treasury, Procurement	Russia	General Electric
109	7000	40/120	750	d-c.	Direct	Non-reversing plate mill	Kaiser Company	Fontana, California	General Electric
110	7000†	25/60	700	d-c.	Direct	Reversing roughing mill	Columbia Steel Company	Provo, Utah	General Electric
111	7000	35/80	700	d-c.	Direct	120 in. universal plate mill	Lukens Steel Company	Coatesville, Pennsylvania	Westinghouse

*—Twin motors
†—Double armature
①—Synchronous
②—Induction

is being urged. Their use could be furthered considerably if the listings of available units were more complete, giving the engineer enough information to determine the characteristics of the machines, as well as information of their age, condition, etc.

Because of the war emergency, control manufacturers have devoted the large part of their development effort to the essential requirements of heavy industry for the manufacture of war material. In general, the priority and allocation situation has precluded obtaining jigs, tools, materials and appliances, unless absolutely essential to the war effort.

Some developments were possible, however, without the need for new manufacturing facilities. One of these is a new d-c crane hoist, which sets new standards for smooth operation and efficient crane performance. Particular attention has been paid to rapid automatic acceleration of the load in both hoisting and lowering. The improved handling of the field, plus four automatic timed accelerating points in either direction, has resulted in faster acceleration with lower current peaks. Five manual control points in either direction assure complete control of the load under all conditions. High speed lowering on light hook is provided, with means to prevent excess speed on heavier loads. Slow inching speeds are provided on the first point hoisting and lowering. Complete protection is provided by adequate electrical and mechanical interlocking.

The manufacture of electric equipment for a large number of huge boring mills for tank turrets resulted in the development of an unique machine tool type of pendant push button. This design, while it mounts 14 push button units, is so arranged that any unit can be operated with one hand without holding the unit with

STATISTICS OF ELECTRIC MOTORS OVER THREE HUNDRED HP

SOLD FOR MAIN ROLL DRIVE SERVICE IN THE IRON AND STEEL INDUSTRY IN 1942

COMPILATIONS

Company	*Location*	*Type of mill*	*Number of motors*	*Total horsepower*
Aluminum Company of America	Heath, Ohio	Reversing blooming mill	1	5,000
		Bar mill breakdown	2	6,000
		Finishing mill	2	2,000
Aluminum Company of America	Massena, New York	Rod and merchant mill	13	10,850
Aluminum Company of America	McCook, Illinois	Reversing tandem plate mill	2	10,000
		Five stand hot mill	5	17,500
		Tandem cold mill	2	4,000
		Single stand cold mills	2	4,000
		Skin pass mills	2	1,600
Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	45 in. slabbing mill	3	13,000
		160 in. plate mill	2	10,000
Columbia Steel Company	Provo, Utah	Slabbing mill	3	10,800
		Semi-continuous plate mill	8	33,250
		Structural mill	3	10,500
Globe Steel Company	Milwaukee, Wisconsin	Sizing mills	2	1,000
Kaiser Company	Fontana, California	Reversing roughing mill	1	5,000
		Slabbing mill	2	7,000
		Plate mill	1	7,000
		Structural finishing mill	1	5,000
		18—14 in. merchant mill	11	7,200
Lukens Steel Company	Coatesville, Pennsylvania	120 in. universal plate mill	3	8,750
National Steel Company of Brazil	Volta Redonda, Brazil	40 in. blooming mill	1	6,000
		72 in. universal plate mill	2	5,600
		Hot strip finishing mill	3	7,500
		Tandem cold strip mill	4	4,050
		Temper mill	2	1,000
Republic Steel Corporation	South Chicago, Illinois	44 in. blooming mill	1	7,000
		36 in. reversing mill	1	5,000
		32 in. reversing intermediate mill	1	5,000
		32 in. reversing finishing mill	1	2,500
Segar Refrigerator Company	Memphis, Tennessee	Sizing mill	1	800
Sheffield Steel Corporation	Houston, Texas	36 in. blooming mill	1	5,000
Taylor Forge and Pipe Works	Chicago, Illinois	Hoop mill	1	800
United Engineering and Foundry Company	Trentwood, Washington	Reversing hot mills	3	10,400
		Five-stand hot mill	5	18,250
		Two-stand cold mill	2	4,500
		Single stand cold mills	2	4,500
		Skin pass mill	1	1,250
United States Treasury Procurement	Russia	Blooming mill	1	7,000
		Reversing hot breakdown mill	1	1,500
		Cold strip mills	6	6,900

Types of motors purchased	*Total motors*	*Total horsepower*
Alternating current motors	14	20,000
Direct current motors	97	263,650
Total	111	283,650

the other hand. Machine tool demands for war work led to the development of a number of special relays for either a-c or d-c use in various types.

Development of various a-c contactors, which started about two years ago, is now completed and these devices are in production. They feature simplified mounting with easy disassembly and assembly, easily removable, entirely visible, double break silver-to-silver contacts, heat resisting non-carbonizing arc shields, tapped coil terminals, vertical lift, hinged arm, hammer head magnet designed for high speed operation, front connected with screwdriver, and all around sturdy construction for heavy duty application.

Other developments are crane hoist limit stops, mill master switches in 2, 3 and 4-pole, master switches in pedestal mounting, and selector switches with from 1 to 24 poles, with 5 or less sequences, and with a lock handle to prevent tampering with established sequences.

The use of two relatively small magnet coils instead of one large single coil on magnetic contactors has materially speeded up action of the contactor. The reduced inductance of the smaller coils, with fewer turns in each coil, results in a faster build-up of the magnetic flux to close the contactor and likewise faster collapse of the flux to drop out the contactor. The net result is quicker response of the controller when the master switch is manipulated. One mill reports that the use of 600 amp contactors of this type on the blooming mill screwdown has resulted in an increase of one ingot per hour in rolling rate, and that roll adjustments are made faster and more accurately.

Control systems based on the use of the small auxiliary exciter have been well received, and their application has broadened to many fields, including skip hoists, reversing drive motors, arc furnace electrode control, cold strip tension regulation, etc., as previously mentioned. Size of the motors to be controlled is of no consequence and the system offers a reduction in the number of control devices. The small relays, which replace large magnetic contactors used in the conventional control system offer rapid, accurate operation.

All through the field of industrial electricity, we see applications of electronic devices becoming more and more common, and it is safe to predict that a broad expansion of devices of this type will occur when conditions return to normal.

Using a method of arc interruption established by years of successful operation of mine hoists, a new air-break, high-voltage a-c contactor has been developed for motor-starting on service voltages of 2300 volts and 4000-5000 volts. Co-ordinated design of an improved blow-out and arc-chute structure contribute to long contact tip life, while low inertia of moving parts and a proven operating magnet contribute to long mechanical life.

This new line of motor-starting equipment is especially recommended where a high-duty cycle is encountered, such as accumulator pump service, or other applications where any oil-immersed contactor would suffer short tip life and rapidly-reduced insulation strength of the oil. In general, the equipment rating allows it to handle squirrel-cage induction motor starting, up to 600 hp at 2300 volts, and 1250 hp at 4160 volts, for motors having not more than 600 per cent locked-rotor current. The starter may also be applied to synchronous and wound-rotor induction motors.

Space requirements of this new contactor are such as to allow the 2300-volt form to be mounted in a completely enclosed, floor-mounted, cabinet-type steel cubicle, approximately 40 inches wide by 46 inches deep. The 4160-volt form requires approximately 12 inches more in width, with exactly the same depth.

By taking this contactor as the magnetic switch and coordinating it with current-limiting power fuses, current transformers, and overload relays, a complete high-voltage motor starter is obtained which inherently provides sufficient current-limiting and interrupting capacity to render it adequate for installation on many systems.

The interrupting capacity on 2300 volts, 3-phase, 60 cycles, is rated 150,000 kva, and on 4000-5000 volts, 250,000 kva. These interrupting capacities are made possible by the fast current-limiting power fuses which are mounted in hook-operated disconnecting supports, thus accomplishing the purpose of an isolating disconnect switch.

Refinements in circuit breaker and switchgear design is continuing, although present modifications are largely along the line of reducing the consumption of critical materials by utilizing substitute materials of a less critical nature.

The operating time of circuit breakers has, however, been materially reduced, thus limiting current rise and clearing systems of heavy short circuit currents. This is of particular import on the large capacity d-c systems, where fault currents rising at the rate of five to six million amperes per second are not unusual. The speed of operation has been increased from the old eight cycle period to as little as one-quarter cycle.

A new method of power factor and voltage control has been applied to a large electric furnace load, using two 20,000 kva condensers. At times of peak load, the controls function to keep the power factor as high as

Figure 16 — This rectifier installation works in parallel with motor-generator sets to durnish d-c power for a blast furnace plant.

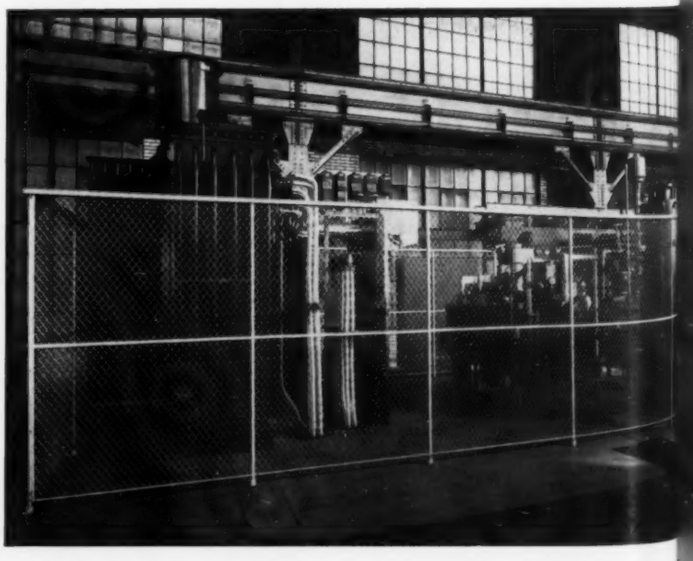


Figure 17 — This rigger truck is a four-motor crane unit equipped with rigid or telescopic boom.

possible consistent with the capacity of the machines. At times of light load, voltage is held within definite preset limits, maximum and minimum. At all times when excess power capacity is available, the load circuits are controlled to minimum integrated reactive kva, either lagging or leading for stipulated periods of integrated power readings.

Prior to 1941, only one 1000 kw rectifier was employed in the steel industry. During the past two years, however, steel mill engineers are turning more and more to rectifier equipment for supplying power needs, and rectifier installations have increased sharply, relieving the pressure on other types of equipment somewhat. The adoption of the rectifier has been brought about by several factors: first, economy of operation and low maintenance; second, greater familiarity with the principles of rectification; third, better delivery, because of less critical material and the great demand for rotating equipment.

Rectifiers have been applied to general plant d-c systems and to variable voltage control systems, and are successfully operated in parallel with motor-generator sets in either case. They have not as yet been applied to reversing mill drives, but this is stated to be a possible development of the future.

A modified rectifier installation is being built to act as an electronic frequency changer, transforming 44,000 volt, 25 cycle power to 66,000 volt, 60 cycle, or vice versa. Two units, of 10,000 kw capacity each, are employed, each consisting of a transformer and an a-c to d-c rectifier having 12 sealed ignitron tubes and a d-c to a-c converter with a transformer and duplicate tubes. The power transformation therefore passes through a d-c phase in going from one a-c frequency to another. Power flow will be regulated automatically by grid control regardless of fluctuations of frequency. The power flow can be reversed by the operator without any switching in the power circuit. This application will be watched with a great deal of interest in the industry.

An experimental electronic ore separator has been developed which shows considerable promise as a means of concentrating metallic ore from low grade deposits. Using an electrostatic principle, this separator can sort dry mixtures of any two materials, provided one is a fair insulator and the other has appreciable conductivity. Ore ground to the fineness of sand trickles on to a rotating metal drum, where the particles receive high-voltage charges from a series of fine wires a short distance from the drum surface. Since the metallic particles are relatively good conductors, the charges seep through them and into the drum. Thus losing their charge, the metallic particles fall off, while the poor conducting sand or rock particles retain their charge and cling to the drum until pulled off by a series of positively charged wires during the last half revolution of the drum.

MATERIAL HANDLING

The revised A. I. S. E. Specifications for Electric Overhead Traveling Cranes for Steel Mill Service, as published in the August issue of the *Iron and Steel Engineer*, represent a great advance from the original specifications brought out in 1910 and subsequently revised in 1916, 1919 and 1929.

Many of the items contained in the new specifications present data published for the first time. The section on girder design is based on research and studies sponsored and financed by the Association of Iron and Steel Engineers, and carried out by I. E. Madsen at Lehigh University. The formulae used recognize all lateral and horizontal forces that must be resisted, and are not modifications of standard column formula or those used in design of bridge structures.

The section on wheel loadings is based on the satisfactory operation of crane wheels and rail sections submitted by many crane users, as well as on the recommendations of crane builders and wheel manufacturers. Investigation of this subject showed the necessity of using rails designed for heavy loads at low speeds, and capable of resisting high lateral thrusts.

The recommended application of anti-friction bearings to crane wheels is covered by a table of ratings based upon operating records of mill installations. The items of possible runway conditions and axle deflections were taken into consideration, as was the question of spare bearings to be carried in stock, etc.

The section of the specifications covering bridge drives is based on the experience of many engineers and on data advanced in a symposium on crane bridge drives published in the A. I. S. E. Yearly Proceedings for 1940.

It is realized that in setting up specifications of equipment of this nature, some discrepancies, omissions, etc., are unavoidable. The Association invites suggestions and criticisms of the specifications, which will be reviewed from the standpoint of the desirability of further revision.

A special generator has been developed for use in connection with crane hoist drives which provides new features, such as high speed hoisting of empty hook, adjustable and not too fast for reliable limit switch operation; definite, adjustable stalling point to limit overloads below the mechanical capacity of the crane; relatively flat speed-load curves for low speed hoisting and lowering; high speed lowering of empty hook with speeds decreasing as loads increase.

Because of the size of contactors required and the excessive space needed for magnetically operated contactors, an ore bridge is being built which will utilize air operated contactors. In addition, a simple self-

regulating system for maintaining control voltages on ore bridges has been developed and placed in operation.

Industrial truck design has tended toward heavier construction without increase in weight by better arrangement of the various elements. Other improvements offer better vision and greater safety of operation. Automatic limit stops and brakes on all motions also contribute to safety. Many models are equipped with time-delay controllers, timed in accordance with the adjustment of relays, preventing plugging. High capacity batteries for trucks have held battery changes to a minimum, a service period of 12 hr or more being usual.

Several new designs perform as load carrier, a crane and a tractor, combining typical operations of all three. As a load carrier, these units have an unobstructed platform 84 in. long x 40 in. wide x 25 in. high, with a rated capacity of 6000 lb. As a crane the units handle up to 2000 lb at 42 in. on the boom, and can lift and transport heavy bulky objects. As a tractor, they haul trailers at speeds up to 5 miles per hour, having previously loaded them with its own crane.

The truck operates with two-wheel drive and four-wheel steering. The frame is of heavy formed plate sections, welded into a one-piece structural unit. The boom is composed of heavy formed channel members, rigidly reinforced.

Under the order of WPB, no truck manufacturer is permitted to begin the manufacture of a truck which has not been a standard model of his line, nor may he build a truck which is not an approved standard model according to the following list:

	Capacity, lb
No lift, high platform	1,000-20,000
No lift, low platform	1,000-20,000
Low lift, high platform	2,000-20,000
Low lift, low platform	2,000-20,000
High lift, low platform	2,000-10,000
Fork or ram	2,000-60,000
Crane	2,000-20,000
Tractor, max. draw bar pull	1,500- 6,000
Motorized low lift	2,000- 6,000
Straddle trucks	10,000-30,000

The use of rubber, protective plating, steel plate and lead is restricted by the same order to certain applications to conserve critical materials.

Under the more recent control of industrial equipment undertaken, no one may purchase an industrial truck, however high their priority, without a specific order from the WPB.

Lifting magnets are now offered with six and eight layer coils, as contrasted with the former four layers of flat ribbon copper, resulting in increased magnetic intensity and lifting power of 135 and 175 per cent, respectively. This is accomplished without increasing the magnet diameter, the larger lifts being the result of magnetism carried through the pieces in contact with the poles to other pieces below and the volume of the lift depending on the intensity of magnetization induced.

For handling hot steel (500-1200 F), a magnet has been developed using a hollow manganese steel bottom plate, with the hollow spaces filled with high temperature magnesia refractory. The refractory layer protects the coils from excessive heat, allowing continuous use of the magnet.

A magnet filling compound, which may be forced into the magnet and which retains a springy consistency at operating temperature, supports the coils against side blows and protects against moisture. The compound does not liquefy or evaporate, so that the protection is permanent.

In handling heavy plate or coils, particularly by crane magnet, roller conveyors are subjected to impact and shock loads which may break down rollers capable of carrying the normal weight. To meet this difficulty, a heavy duty conveyor roll equipped with roller bearings has been developed. It is designed to permit expansion where heat is present, and is supported on large precompressed springs housed in 9 in. and 10 in. tubes. The slight give in these springs absorbs most of the shock, and the design has given good service in severe applications.

A reversible transfer, using two-way ducking dogs with spring protection to absorb shock, has also been developed, and has been used to good advantage in handling heavy plate.

MECHANICAL DEVELOPMENTS

With continuous operation of all steel plant equipment and machinery more important than ever, lubrication is receiving even greater attention than usual. Steel plant lubrication imposes upon the lubricant the general conditions of high bearing pressures, shock loads, the presence of water, and a wide temperature range. Greases have been improved so as to offer maximum resistance to softening and deterioration at elevated temperatures, thus maintaining the lubricating film and reducing leakage from the bearing. Increased water resistance prevents the grease from washing off, and higher load carrying ability gives maximum protection against wear. The action of grease in feeding systems has been improved, with better resistance to separation into basic oil and soap base under pressure, and a high consistency index to permit easy feeding with varying temperature.

Extreme pressure lubricants used in the steel plants are generally of the lead oleate or lead naphthenate types. The former has high load carrying characteristics, but possesses certain disadvantages as regards oxidation and low resistance to water. The latter type has improved resistance to water and oxidation, but has a lower load carrying capacity. The addition of certain other ingredients, all mutually soluble in each other and in the selected base oils, to the lead naphthenate type has raised the film strength while retaining good resistance to oxidation and water.

The lubricating qualities of a good oil stock are improved by one manufacturer by treatment with sunthetic organic compounds, thus raising film strength, increasing "oiliness," improving oxidation stability, and tending to reduce deposits. These patented chemical additives are also adaptable to gear oils, giving a high viscosity index, low cold tests, and freedom from foaming, sludging or tendency to corrode the gears.

Tin conservation has brought about a complete overhauling of the conventional standards for the various alloys normally containing this metal. The tin-base babbitt metal, containing 80-90 per cent tin, has practically disappeared except for certain special uses, being largely replaced by the lead-base alloy, containing 10-12

per cent tin. Also undergoing test are several new mixtures, containing 10-12 per cent arsenic and sometimes 2-3 per cent silver, with as little as .75-3.00 per cent tin. Mixtures of this type are on trial in electric motors, fans, air compressors, transfer cars, shears, mill pinion boxes, large engine crank pin boxes, etc.

Tin bronze compositions have also been revised, reducing the tin content by about 40 per cent, and adding zinc, lead and nickel. One steel company has formed a chart of the recommended substitutes (see *Iron and Steel Engineer*, October, 1942), and reports that the new analyses have been in service for several months with satisfactory results.

The shortage of various critical metals used in bearings and similar parts has accelerated the application of composition parts. These phenolic laminated fabric parts weigh 80 per cent less than bronze, and their non-corrosive finish is not affected by water, and highly resistant to weak acids and weak alkalies. They are moulded to finished dimensions, thus eliminating machining, and have been used in place of metals in a wide range of applications, often with even more satisfactory results. Of late, composition bearings have been used in stern tube and rudder stock bearings in merchant marine ships, replacing rubber and lignum vitae.

Figure 18 — Precise control in this variable core arc welded affords minute heat adjustments over the entire transformer range.

Hardened steel parts have been applied to a constantly broadening number of uses in steel plant equipment, with fine results. It is estimated that a pound of steel applied in this way will replace 2 to 10 pounds of common steel which may be used to advantage elsewhere, at the same time saving man-hours for fabrication of replacement parts. This claim is based on a great many mill service reports. Application in table gears, crane wheels, brake wheels, sheave wheels, pig casting wheels, sprockets, pinions, gears, straightener rolls, coiler rolls, pinch rolls, etc., have shown service running from at least 2 or 3 times the life up to 6 or 10 times the life in the case of unhardened material. A test between carbon steel screws and bronze nuts and hardened steel screws and nuts in a blooming mill showed the latter to give a final cost per ton of steel rolled of but 1/5 the cost of carbon steel screws and brass nuts.

Developments in the oxy-acetylene field have been accelerated to a marked extent during the past two years as a result of the demands of our peak production. The old welding and cutting processes have been pressed into new fields, and new uses are being found which in turn require some development in apparatus, machines, and gas handling equipment. High production cutting equipment for flame-cutting on billets, blooms, slabs and ingots were required, as were plate cutting and edging devices. Much armor plate is cut and treated by oxy-acetylene processes.

The use of oxy-acetylene desurfacing machines as a means of conditioning the surface of blooms, billets, and slabs continues to grow. Machines of this type are available in several sizes, each of which may be rolled in and out of the rolling mill line on a transfer carriage, and are easily adjustable for a wide range of steel sizes. Machines of this type have done much to combat the man-power crisis which faces the industry.

Much of the steel intended for shell blanks is broken into length with the aid of oxy-acetylene nicking, a very rapid process. A shallow groove is cut across the billet face, setting up high internal stresses which aid in making a sheer, square fracture under subsequent action of a breaking hammer or press. In many cases it has been found necessary to nick only one side of the billet, although parallel nicks on opposite sides insure a square break. A nick $\frac{3}{16}$-$\frac{1}{4}$ in. deep is usually sufficient. The nicking may be done on machines designed for the purpose, or it may be done — more slowly, of course — manually.

A new line of variable core arc welders uses a precision heat control which enables the operator to get minute heat adjustments over the entire transformer range. The reduction of "arc blow" to a minimum permits the use of large diameter electrodes, which means more metal deposited in less time, and consequently, greater production. These units are capable of operating continuously, 24 hr per day.

Roll grinders have been developed to meet the need for a high output of precision ground rolls with a minimum of skill on the part of the operator. Many important new features have been incorporated to improve accuracy in setup and operation. Machines may grind rolls with either straight, concave or convex contours, or in some cases tapers can be ground.

The step-up in quality and efficiency of cutting tools over recent years has brought about a parallel effort in the development of heavy duty machine tools able to use these tools to the limits of their capabilities, thus speeding production. Typical of this is a series of heavy duty lathes, 48-72 in. in size, with lengths of 15-85 ft between centers. It is stated that stock removal in roughing cuts is 50 per cent faster than in conventional lathes. The feed system is built to operate four tools on any grade of machineable steel or cast iron. Roughing cuts of 2 in. depth and $\frac{1}{4}$ in. feed are practical, and finishing to within .002 in. accuracy may be performed on the same machine.

TO EXECUTIVES:

NOW YOU CAN HELP

Even More...

New Treasury Ruling Permits Purchases UP TO $100,000, in any Calendar Year, of Series F and G WAR BONDS!

The Treasury's decision to increase the limitations on the F and G Bonds resulted from numerous requests by purchasers who asked the opportunity to put more money into the war program.

This is not a new Bond issue and not a new series of War Bonds. Thousands of individuals, corporations, labor unions, and other organizations have this year already purchased $50,000 of Series F and G Bonds, the old limit. Under the new regulations, however, these Bond holders will be permitted to make additional purchases of $50,000 in the remaining months of the year. The new limitation on holdings of $100,000 in any one calendar year in either Series F or G, or in both series combined, is on the cost price, not on the maturity value.

Series F and G Bonds are intended primarily for larger investors and may be registered in the names of fiduciaries, corporations, labor unions and other groups, as well as in the names of individuals.

The Series F Bond is a 12-year appreciation Bond, issued on a discount basis at 74 percent of maturity value. If held to maturity, 12 years from the date of issue, the Bond draws interest equivalent to 2.53 percent a year; computed on the purchase price, compounded semiannually.

The Series G Bond is a 12-year current income Bond issued at par, and draws interest of 2.5 percent a year, paid semiannually by Treasury check.

Don't delay—your "fighting dollars" are needed *now.* Your bank or post office has full details.

Save With . . .

War Savings Bonds

This space is a contribution to America's All-Out War Program by Iron and Steel Engineer

Ramparts of Production

With Continental it is not "too little and too late."

One reason for this is the spirit and the hard work poured into arms production by our men and women. Into this tremendous task Continental has thrown every ounce of heart and strength.

Together, for the past year, Continental men and machines, working three shifts, seven days a week, have manned tirelessly the Ramparts of Production. We feel a patriotic pride in new production records set, and are deeply grateful for recognition given us by the Army and Navy. Another year begins with every man and woman of Continental determined to surpass past records in the production of quality war equipment for the fighting men who inspire our efforts.

* * *

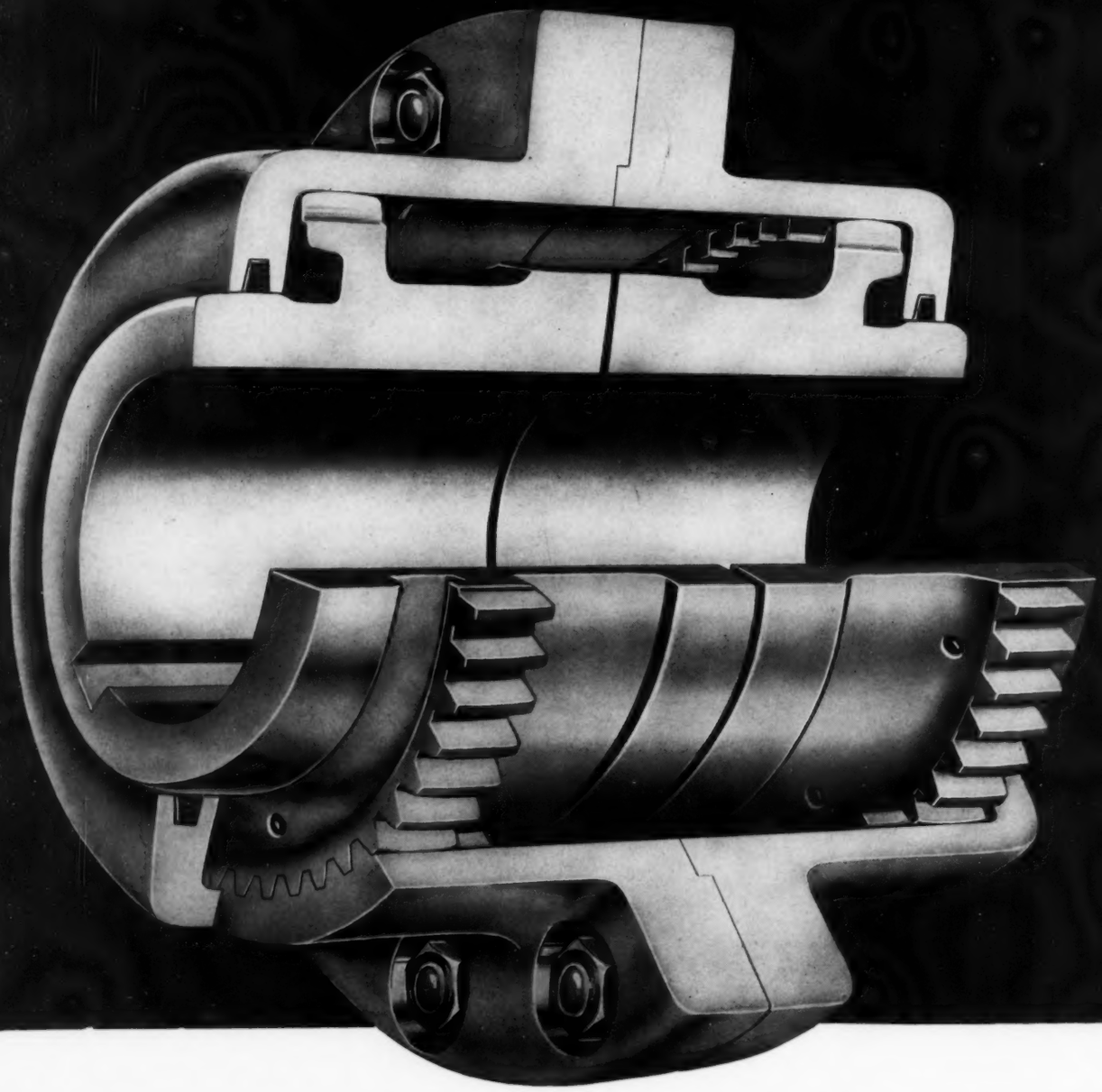
Continental products include carbon and alloy steel castings, armor castings, rolls, rolling mill equipment, and special machinery of many types.

CONTINENTAL

ROLL AND STEEL FOUNDRY COMPANY

CHICAGO • PITTSBURGH

POOLE



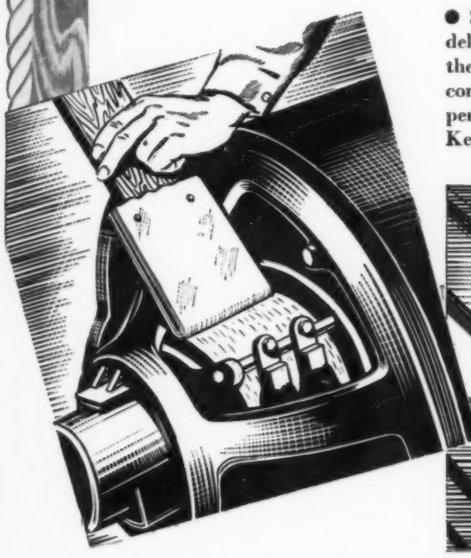
A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

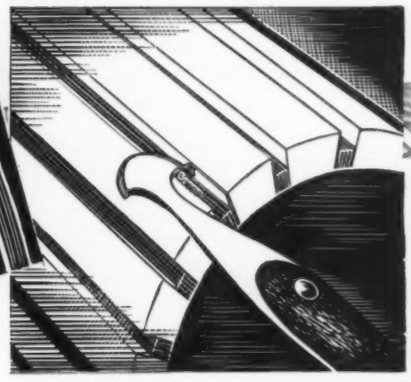
The A B C of Good Commutation and Electrical Machine Performance

● Serious shutdowns and consequent delays in the production and delivery of urgently needed materials can be avoided by observing these simple precautions in the maintenance of motors, generators and converters. Under present conditions, dependable and uninterrupted performance of electrical power equipment is of utmost importance. Keep your machines in readiness to deliver full output at all times.



Keep Commutators and Rings Clean

Cleanliness is of paramount importance in the continuous operation of brush-using equipment. Time spent on keeping commutators, rings, brush holders and rigging free from dust, dirt, oil and film pays dividends. Use a suitable canvas wiper frequently on commutators and rings. Keep them clean and keep them running.



Keep Undercut Commutators Free from Side Mica

Thin edges of mica along the sides of slots of undercut commutators are a frequent source of trouble. Special care should be taken to inspect each slot carefully and to remove all side mica when undercutting commutators. Bad sparking and serious commutator burning can be avoided by observing this precaution.

Keep Brush Pressure Uniform and Correct

The spring pressure applied to brushes has a marked influence on brush performance. Equal distribution of current among all brushes requires that the pressure on all brushes be kept as nearly equal as possible. Check brush pressure frequently and adjust it to compensate for brush wear. Use pressures recommended for the grade of brush and class of service in which it is used.

MODERN PYRAMIDS will tell you more

This series of bulletins contains practical information on Commutation, Brush Operation and Machine Maintenance to help conserve present equipment and to keep it in continuous and efficient operation. If you are not receiving these bulletins write us direct or contact your National Carbon representative.

The services of our engineering staff are available for the proper selection and application of "National" Carbon Brushes on all types of equipment and for every class of service.

LET'S GO! U.S.A. KEEP 'EM FLYING!

NATIONAL CARBON COMPANY, INCORPORATED

Unit of Union Carbide and Carbon Corporation

UCC

Carbon Sales Division, Cleveland, Ohio • • GENERAL OFFICES: 30 East 42nd Street, New York, N. Y.

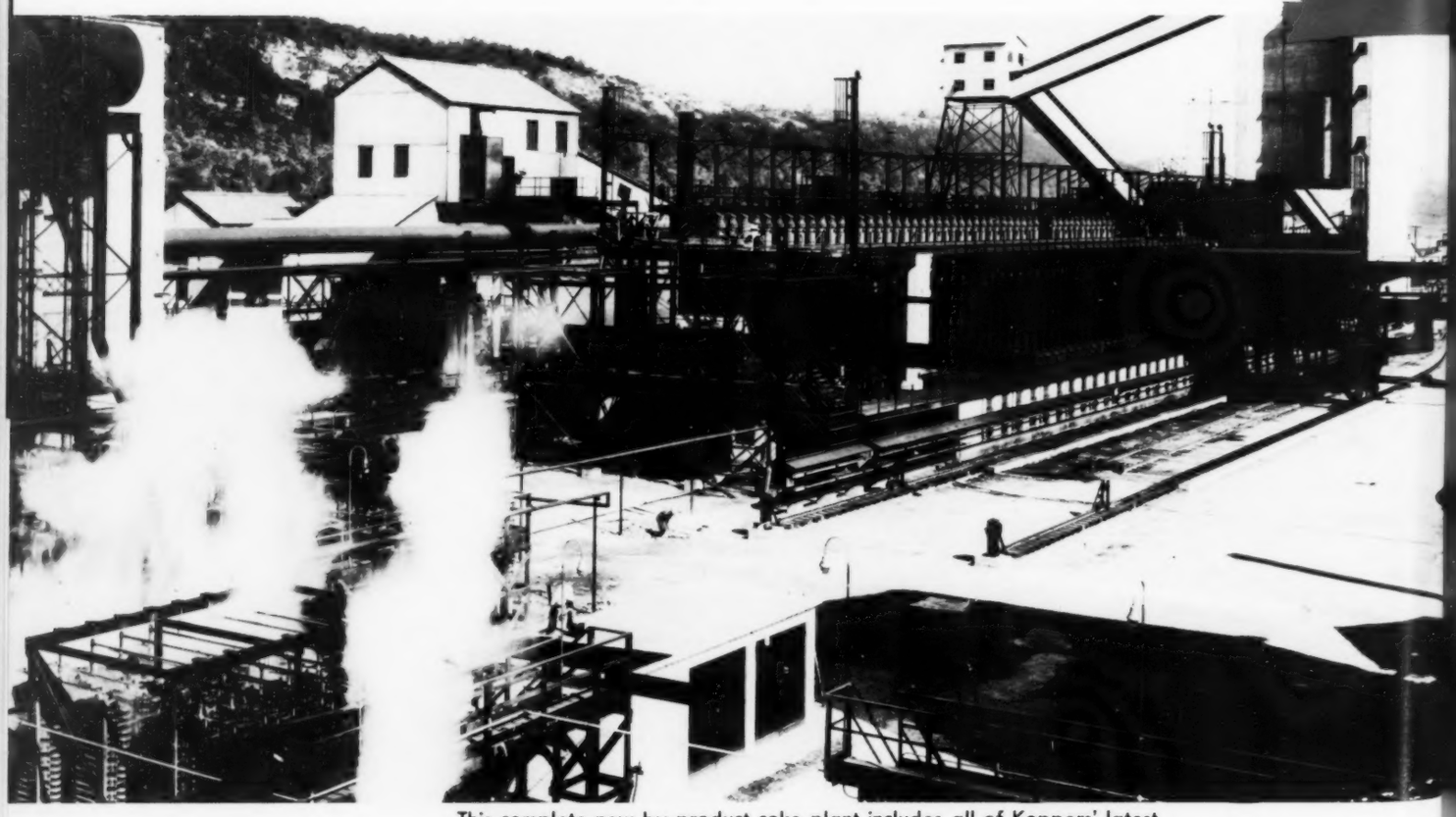
Branch Sales Offices: NEW YORK • PITTSBURGH • CHICAGO • ST. LOUIS • SAN FRANCISCO

History is being made . . .

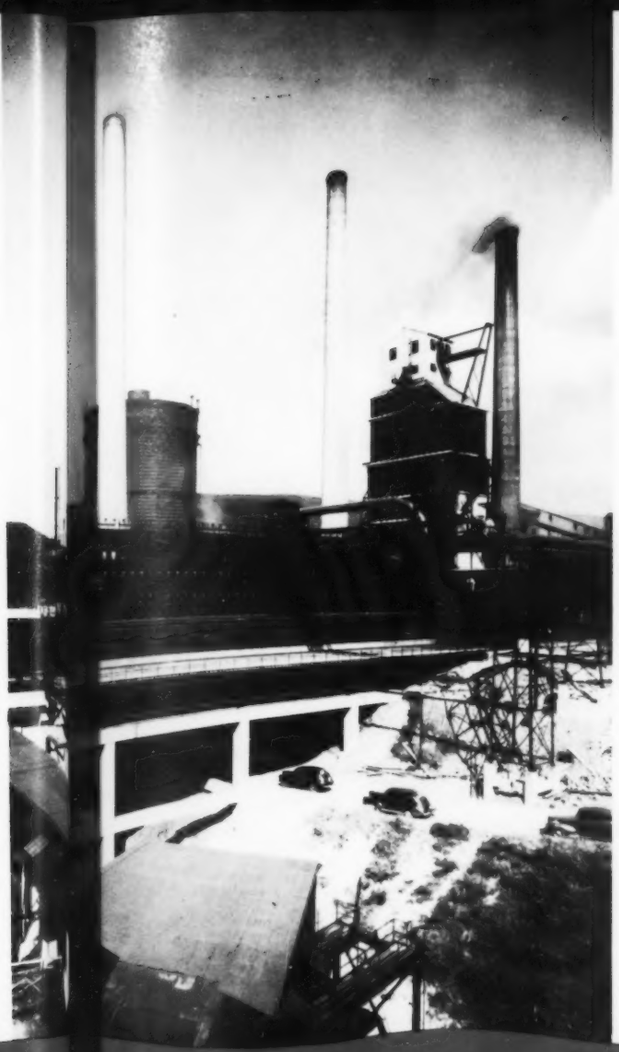
in coke plants, too

New coke oven plants by Koppers will produce in excess of 5,000,000 additional tons of coke per year, together with all the by-products. This is vital to the growth of America's war effort.

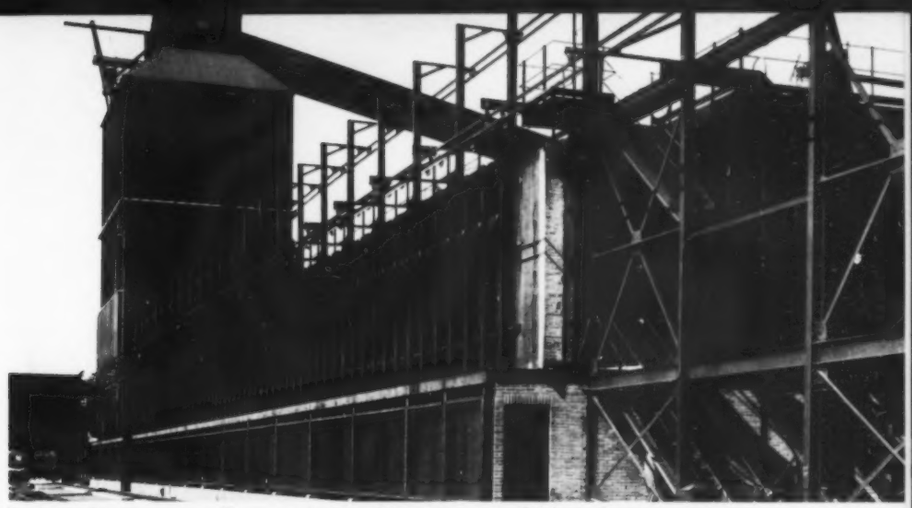
Shown on these pages are five of these new plants which have invaluable new features.



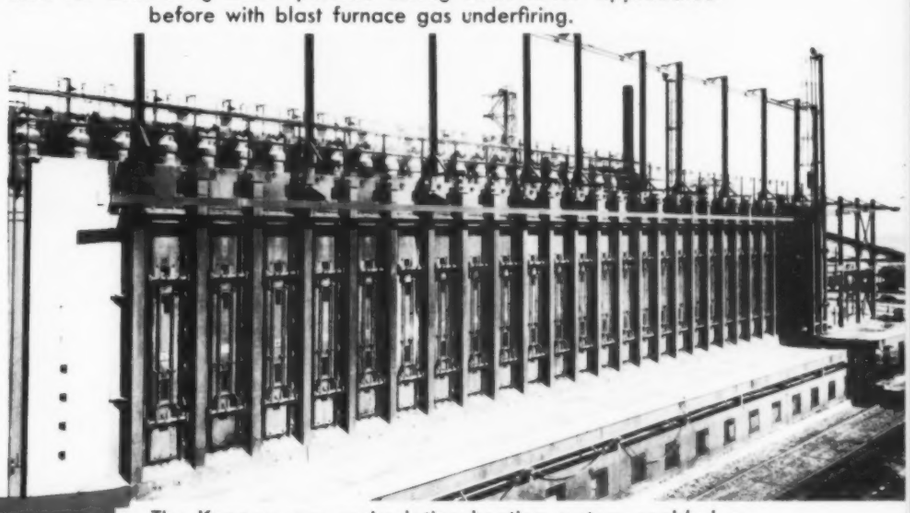
This complete new by-product coke plant includes all of Koppers' latest designs for coke oven, by-product and material handling equipment.



In this installation, Koppers engineered and erected a battery of coke ovens to conform to a restricted site.



In these large ovens, Koppers internal enrichment of blast furnace gas used for underfiring made possible coking rates never approached before with blast furnace gas underfiring.



The Koppers gas recirculation heating system enabled a gas company to underfire these ovens with refinery still gas.

A minimum of critical materials was used in this installation of two batteries of 45 ovens each. Construction was carried out with only about 50% of the usual amount of steel.

KOPPERS COMPANY

PITTSBURGH, PA.

Engineering and Construction Division

DELTAGLASS

ELIMINATES FREQUENT MOTOR FAILURES

Maintaining top production builds up intense heat in your motors. Fantastic war schedules mean continuous operation without a let-up for "cooling-off" periods. But you needn't worry. Your motors will keep running even in high overload temperatures . . . when they are wound with Deltaglass Magnet Wires.

Deltaglass Magnet Wire is designed for the most intricate and difficult winding jobs. It is insulated with a yarn of pure, continuous filament or spun glass that is firmly bonded to the copper conductor with a special heat-resistant insulating varnish. Deltaglass is available with either single or double wraps of glass yarn or with enameled copper conductors covered with a single or double wrap of spun glass. It has a compact and flexible wall of fireproof insulation which will withstand a great amount of abrasion, bending and flexing without rupturing the insulation. All raw materials are accurately inspected and tested in our modern laboratory. Deltaglass Magnet Wires are constructed in round, square and rectangular shapes.

G-E Deltaglass Magnet Wires are distributed by Graybar Electric Co., G-E Supply Corp. and other G-E Merchandise Distributors.

For more information on G-E Deltaglass Magnet Wires ask for the new Deltabeston Catalog by writing to Section Y131-31, Appliance and Merchandise Department, General Electric Company, Bridgeport, Conn.

Features of Deltaglass:

• *High Heat and Moisture Resistant* • *Copper Free from Burrs and Slivers* • *Dead Soft Copper* • *Small Diameter* • *High Dielectric Strength* • *Wide Range of Sizes* • *Impervious to Oil and Acids* • *Superior Thermal Conductivity* • *Resists Vibration* • *Greater Flexibility*

GENERAL ELECTRIC

IRON AND STEEL ENGINEER INDEX FOR 1942

Herewith is presented the index of all authors, papers, and discussions published in the IRON AND STEEL ENGINEER for the year 1942

LIST OF AUTHORS

A

ADELSON, J. S. — *Manufacture of Electric Resistance Welded Pipe and Tubing,* August, 1942, Page 33.
ALEXANDER, E. H.— *Developments in Control Equipment and Devices,* December, 1942, Page 56.
ANGEL, H. H.— *Special Applications of Steel Plant Control,* December, 1942, Page 50.
ARMSTRONG, PAUL S.— *Electrolytic Protection of Water Systems,* October, 1942, Page 34.

B

BAILEY, C. A.— *Oil Filtration and Reclamation,* May, 1942, Page 61.
BETZ, P. L.— *Performance of Various Gases in the Oxygen Cutting Process,* July, 1942, Page 64.
BEYERLE, W. H.— *Brushes and Brush Application,* October, 1942, Page 40.
BLOOM, F. S.— *Fuel Application in Metallurgical Heating Furnaces,* February, 1942, Page 64.
BLUMBERG, H. S.— *Alloy Steel Cladding and Pressure Vessels,* October, 1942, Page 70.
BROWN, C. E.— *Substitute Coatings for Tin Plate,* July, 1942, Page 30.
BROWN, W. T.— *Methods of Increasing Production of Existing Steel Plant Equipment — Coke Plants,* January, 1942, Page 51
BURR, W. H.— *Developments in the Iron and Steel Industry during 1941,* January, 1942, Page 26.
BURT, F. R.— *Adjustable Voltage Skip Hoist Control,* August, 1942, Page 38.

C

CAMPBELL, J. D.— *Special Electrical Applications in the Steel Industry,* February, 1942, Page 78.
COOPER, J. H.— *Welding in Cold Strip Processing,* July, 1942, Page 46.

D

DITCHMAN, J. P.— *Steel Mill Lighting in Wartime,* September, 1942, Page 128.
DUNMIRE, R. P.— *The Influence of Water on the Lubricating Value of Mill Bearing Oil,* November, 1942, Page 30.
DUNMIRE, R. P.— *Maintenance of Insulating Oils,* December, 1942, Page 42.
DUNNE, R. VD.— *Economic Aspects of Pre-Compression Refrigerated Dry Blast,* July, 1942, Page 56.

E

ERBE, J. RAYMOND — *IR Drop Compensation on Cleaning Lines,* December, 1942, Page 53.
ESS, T. J.— *Atlantic Steel Company,* March, 1942, Page 45.
ESS, T. J.— *Copperweld Steel Company's Alloy Plant,* May, 1942, Page 35.
ESS, T. J.— *Dominion Foundries and Steel, Ltd.,* April, 1942, Page 37.
ESS, T. J.— *Steel Company of Canada, Ltd.,* April, 1942, Page 69.
ESS, T. J.— *Steel's Bid for Victory,* September, 1942, Page 51.
EVANS, D. N.— *Diesel Engine Lubrication,* July, 1942, Page 38.

F

FLEMING, W. J.— *Is Maintenance and Design a Partnership?* November, 1942, Page 58.
FOUNTAIN, L. L.— *Low Voltage Distribution Systems in Steel Mills,* November, 1942, Page 50.
FOUNTAIN, L. L., and H. A. TRAVERS — *Grounded D-C Systems for Steel Mills,* March, 1942, Page 68
FRANZ, A. F.— *Increased Production from Existing Plate Mill Equipment,* January, 1942, Page 74.
FULLER, ERNEST — *The Sintering Plant at Great Lakes Steel Corporation,* May, 1942, Page 27.

H

HALSTEAD, HOWARD — *Temperature Control of Galvanizing Kettles,* November, 1942, Page 64.
HARBAUGH, M. D.— *Survey of the Iron Ore, Pig Iron and Scrap Situation,* November, 1942, Page 26.
HORKO, W. N.— *Increased Production from Existing Billet Heating Furnaces,* January, 1942, Page 70.

J

JENNINGS, C. J. and A. B. WHITE — *Electric Welding Machines,* June, 1942, Page 50.

K

KENTIS, GEORGE — *Slitting — An Old Problem Modernized,* February, 1942, Page 30.
KENYON, A. F.— *Electrical Drives for a 110 Inch* Reversing *Plate Mill,* November, 1942, Page 73.
KULP, R. K.— *Woody Fractures,* February, 1942, Page 39.

L

LIAS, L. P.— *Methods of Increasing Production of Existing Steel Plant Equipment — Bessemer and Duplexing,* January, 1942, Page 60.
LOHREY, C. R.— *Production of Benzol Products by the Continuous Process,* August, 1942, Page 46.
LORENZI, OTTO DE — *Stoker Application for Combination Firing of Boilers,* March, 1942, Page 74.
LOUGHREY, D. R.— *The Design, Construction and Operation of a Bessemer Converting Mill,* March, 1942, Page 28.

M

McKEE, ARTHUR G.— *Some Aspects of the Proposed Steel Expansion Program,* January, 1942, Page 82.
McLOUGHLIN, T. J.— *An Organization of Fuel Department Personnel and Practice,* March, 1942, Page 61.
MALBORN, JOSEPH — *Methods of Increasing Production of Existing Steel Plant Equipment — Mill Equipment,* January, 1942, Page 63.
MAWHINNEY, M. H.— *Modern Bloom and Billet Heating Furnaces,* May, 1942, Page 70.
MILBURN, L. R.— *Mercury-Arc Rectifier vs Motor-Generator,* December, 1942, Page 28.
MONTGOMERY, T. B.— *The Temper Mill,* April, 1942, Page 90.
MORGAN, M. F.— *The Design and Operation of a Modern Sintering Plant,* April, 1942, Page 103.

P

J. F. PELLEY and JOHN WORTH — *Tin Substitutes Prove Satisfactory in Bronzes,* October, 1942, Page 44.
PERRY, W. A.— *Systematic Inspection and Maintenance of Steel Plant Electrical Equipment,* September, 1942, Page 113.
PFEFFER, G. C.— *Maintenance of Hydraulic Equipment,* October, 1942, Page 43.
PFEIL, A. L.— *A New Hammered Resistance Welding Process,* August, 1942, Page 42.
POOLE, H. W.— *Motor Applications and Power Requirements for Strip Processing Lines,* September, 1942, Page 33.
PORTER, C. J.— *Electrical Drives for a 110 Inch Reversing Plate Mill,* November, 1942, Page 73.
PRICE, C. A.— *Electrical Drives for a 110 Inch Reversing Plate Mill,* November, 1942, Page 73.

R

RESWICK, MAURICE — *New Developments in Lubricants for Steel Plants,* October, 1942, Page 55.
RICE, O. R.— *Blast Furnace Gas Cleaning,* December, 1942, Page 66.
RIDDLE, L. E.— *Methods of Increasing Production of Existing Steel Plant Equipment — Blast Furnaces,* January, 1942, Page 55.
ROSENSTIEHL, F. E.— *Design of Lubricants for Mechanized Lubrication,* March, 1942, Page 83.

S

SEE, W. G.— *Submerged Combustion Heating for Pickling Baths,* June, 1942, Page 62.
W. A. SMILEY — *Application and Control of Capacitors on Multi-phase Loads,* October, 1942, Page 26.
SMITH, E. W. P.— *Advanced Methods of Arc Welding,* May, 1942, Page 31.
STOLTZ, G. E.— *Report of Field Tests on IR Drop Compensation,* May, 1942, Page 51.
STONE, M. D.— *Electrolytic Tinplate,* February, 1942, Page 90.
SUCCOP, J. A.— *Backing-Up Rolls,* September, 1942, Page 42.
SWARTZ, F. C.— *Methods of Increasing Production of Existing Steel Plant Equipment — Open Hearths,* January, 1942, Page 57.

T

THEISINGER, W. G.— *Welding Nickel, Monel and Incone l Clad Steels,* October, 1942, Page 75.
TRAVERS, H. A. and L. L. FOUNTAIN — *Grounded D-c Systems for Steel Mills,* March, 1942, Page 68.
TUCK, DAVIS H.—*Blackout Lighting — A Discussion of British and American Practice,* March, 1942, Page 81.
TUCK, D. H.— *Protective Lighting for Industrial Plants,* July, 1942, Page 42.

U

ULLMAN, FRED E.— *Recovery and Preparation of Steel Scrap from Steel-Making Furnace Slag and Refuse,* August, 1942, Page 27.

V

V. C. VAALER — *Recent Advances in the Control of Multi-Fuel Fired Furnace,* September, 1942, Page 134.
VAN ARTSDALEN, G. A.— *Increased Production from Existing Arc Melting Furnaces,* January, 1942, Page 78.
VAN DER HOEVEN, B. J. C.— *Effect of Rate of Operation in the Coke Plant,* June, 1942, Page 68.
VAN PELT, A. A.— *Maintenance of Ball and Roller Bearings,* October, 1942, Page 65.

W

WEIKEL, R. A.— *Maintenance of Instruments and Controls in the Steel Plant,* April, 1942, Page 115.
WHITCOMB, ARTHUR J.— *New Developments in Blast Furnace Charging,* June, 1942, Page 29.
WHITE, A. B. and C. J. JENNINGS — *Electric Welding Machines,* June, 1942, Page 50.
WHITE, H. A.— *Developments in Non-Ferrous Bearing Metals,* October, 1942, Page 46.
WILCOX, H. L.—*Trends in the Design of D-c Control,* November 1942, Page 38.
WINLACK, G. D.— *Scarfing High Carbon and Alloy Steels,* April, 1942, Page 26.
WORTH, JOHN and PELLY, J. F.— *Tin Substitutes Prove Satisfactory in Bronzes,* October, 1942, Page 44.
WRIGHT, F. A.— *Modern Construction of A-c Motor Control,* November, 1942, Page 44.
WRIGHT, R. H.— *Engineering for Increased Production in the Steel Industry,* September, 1942, Page 123.

Z

ZIMMERMAN, J. H.— *Oxy-Acetylene Defense Developments,* June, 1942, Page 76.

LIST OF SUBJECTS

A

Abstracts of Papers to be Presented, Association of Iron and Steel Engineers Annual Meeting and Engineering Conference — September, 1942, Page 142.
A-c Motor Control, Modern Construction of — F. A. WRIGHT, November, 1942, Page 44.
Adjustable Voltage Skip Hoist Control — F. R. BURT, August, 1942, Page 38.
Advanced Methods of Arc Welding — By E. W. P. SMITH, May, 1942, Page 31.
Alloy Plant, Copperweld Steel Company's — By T. J. ESS, May, 1942, Page 35.
Alloy Steel Cladding and Pressure Vessels — By H. S. BLUMBERG, October, 1942, Page 70.
Alloy Steels, Scarfing High Carbon and — By G. D. WINLACK, April, 1942, Page 26.
A New Hammered Resistance Welding Process — By A. L. PFEIL, August, 1942, Page 42.
Application and Control of Capacitors on Multi-phase Loads — By W. A. SMILEY, October, 1942, Page 26.
Applications of Steel Plant Control, Special — By H. H. ANGEL, December, 1942, Page 50.
Arc Melting Furnaces, Increased Production from Existing — By G. A. VAN ARTSDALEN, January, 1942, Page 78.
Arc Welding, Advanced Methods of — By E. W. P. SMITH, May, 1942, Page 31.
Aspects of the Proposed Steel Expansion Program, Some — By ARTHUR G. McKEE, January, 1942, Page 82.
Atlantic Steel Company — By T. J. ESS, March, 1942, Page 45.

B

Backing-Up Rolls — By J. A. SUCCOP, September, 1942, Page 42.
Ball and Roller Bearings, Maintenance of — By A. A. Van PELT, October, 1942, Page 65.
Bearing Metals, Developments in Non-Ferrous — By H. A. WHITE, October, 1942, Page 46.
Bearing Oil, The Influence of Water on the Lubricating Value of Mill — by R. P. DUNMIRE, November, 1942, Page 30.
Bearings, Maintenance of Ball and Roller — By A. A. VAN PELT October, 1942, Page 65.
Benzol Products by the Continuous Process, Production of — By C. R. LOHREY, August, 1942, Page 46.
Bessemer and Duplexing, Methods of Increasing Production of Existing Steel Plant Equipment — By L. P. LIAS, January, 1942, Page 60.
Bessemer Converting Mill, The Design, Construction and Operation of a — By D. R. LOUGHREY, March, 1942, Page 28.
Billet Heating Furnaces, Increased Production from Existing — By W. N. HORKO, January, 1942, Page 70.
Billet Heating Furnaces, Modern Bloom and — By M. H. MAWHINNEY, May, 1942, Page 70.
Blackout Lighting — A Discussion of British and American Practice — By DAVIS H. TUCK, March, 1942, Page 81.
Blast Furnace Charging, New Developments in — By ARTHUR J. WHITCOMB, June, 1942, Page 29.
Blast Furnace Gas Cleaning — By O. R. RICE, December, 1942, Page 66.
Blast Furnaces, Methods of Increasing Production of Existing Steel Plant Equipment — By L. E. RIDDLE, January, 1942, Page 55.
Bloom and Billet Heating Furnaces, Modern — By M. H. MAWHINNEY, May, 1942, Page 70.
Boilers, Stoker Application for Combination Firing of — By OTTO DE LORENZI, March, 1942, Page 74.
Bronzes, Tin Substitutes Prove Satisfactory in — By J. F. PELLY and JOHN WORTH, October, 1942, Page 44.
Brushes and Brush Application — By W. H. BEYERLE, October, 1942, Page 40.

C

Capacitors on Multi-phase Loads, Application and Control of — By W. A. SMILEY, October, 1942, Page 26.
Carbon and Alloy Steels, Scarfing High — By G. D. WINLACK, April, 1942, Page 26.
Charging, New Developments in Blast Furnace — By ARTHUR J. WHITCOMB, June 1942, Page 29.
Cleaning Lines, IR Drop Compensation on — By J. R. ERBE, December, 1942, Page 53.
Cleaning, Blast Furnace Gas — By O. R. RICE, December, 1942, Page 66.
Coatings for Tin Plate, Substitute — Presented by C. E. BROWN, July, 1942, Page 30.
Coke Plant, Effect of Rate of Operation in the — By B. J. C. VAN DER HOEVEN, June, 1942, Page 68.
Coke Plants, Methods of Increasing Production of Existing Steel Plant Equipment — By W. T. BROWN, January, 1942, Page 51.
Cold Strip Processing, Welding in — By J. H. COOPER, July, 1942, Page 46.
Combination Firing of Boilers, Stoker Application for — By OTTO DE LORENZI, March, 1942, Page 74.
Compensation on Cleaning Lines, IR Drop — By J. R. ERBE, December, 1942, Page 53.
Control Equipment and Devices, Developments in — By E. H. ALEXANDER, December, 1942, Page 56.
Controls in the Steel Plant, Maintenance of Instruments and — By R. A. WEIKEL, April, 1942, Page 115.
Converting Mill, The Design, Construction and Operation of a Bessemer — By D. R. LOUGHREY, March, 1942, Page 28.
Copperweld Steel Company's Alloy Plant — By T. J. ESS, May, 1942, Page 35.

Cranes for Steel Mill Service, Specification for Electric Overhead Traveling — August, 1942, Page CS-1.

D

D-c Control, Trends in the Design of — By H. L. WILCOX, November, 1942, Page 38.
D-c Systems for Steel Mills, Grounded — By L. L. FOUNTAIN and H. A. TRAVERS, March, 1942, Page 68.
Defense Development, Oxy-Acetylene — By J. H. ZIMMERMAN, June, 1942, Page 76.
Design and Operation of a Modern Sintering Plant, The — By M. F. MORGAN, April, 1942, Page 103.
The Design, Construction and Operation of a Bessemer Converting Mill — By D. R. LOUGHREY, March, 1942, Page 28.
Design of Lubricants for Mechanized Lubrication — By F. E. ROSENSTIEHL, March, 1942, Page 83.
Developments in Control Equipment and Devices — By E. H. ALEXANDER, December, 1942, Page 56.
Developments in Non-Ferrous Bearing Metals—By H. A. WHITE, October, 1942, Page 46.
Developments in the Iron and Steel Industry During 1941 — By W. H. BURR, January, 1942, Page 26.
Diesel Engine Lubrication — By D. N. EVANS, July, 1942, Page 38.
Discussion: Advanced Methods of Arc Welding — Presented by A. W. STEED, A. B. WHITE, J. S. McKEIGHAN, and E. W. P. SMITH, May, 1942, Page 34.
Discussion: Alloy Steel Cladding and Pressure Vessels and Welding, Nickel, Monel and Inconel — Presented by N. C. BYE, W. H. JOHNSON, C. M. THOMPSON, BASIL OSMIN, STUART B. MATHEWS, MARTIN J. CONWAY, H. S. BLUMBERG and W. G. THEISINGER.
Discussion: The Design and Operation of a Modern Sintering Plant — Presented by J. C. MURRAY, M. F. MORGAN, G. W. HEWITT, K. G. LeVISEUR, H. A. BYRNS, E. W. SHALLOCK, GUY WEHR, C. P. BETZ, W. T. BROWN, R. A. LINDGREN, T. W. PLANTE, C. M. MYERS, and F. F. FOSS, April, 1942, Page 105.
Discussion: The Design, Construction and Operation of a Bessemer Converting Mill — Presented by J. S. FULTON, H. T. BOWMAN, F. F. FOSS, and H. L. McFEATERS, March, 1942, Page 37.
Discussion: Design of Lubricants for Mechanized Lubrication — Presented by N. C. BYE, H. B. CLEAVELAND, L. F. COFFIN, C. R. HAND, and F. E. ROSENSTIEHL, March, 1942, Page 88.
Discussion: Developments in Non-Ferrous Metals — Presented by L. F. COFFIN, H. A. WHITE, E. W. TREXLER, L. C. SENTANCE, October, 1942, Page 52.
Discussion: Diesel Engine Lubrication — Presented by T. R. MOXLEY and D. N. EVANS, July, 1942, Page 41.
Discussion: Economic Aspects of Pre-Compression Refrigerated Dry Blast — Presented by J. A. CLAUSS, R. VD. DUNNE, L. L. LEWIS, W. J. REES, and G. R. McDERMOTT, July, 1942, Page 59.
Discussion: Effect of Rate of Operation in the Coke Plant — Presented by W. T. BROWN, M. D. WALD, W. H. COLLISON, WILLIAM R. PENDRY, C. P. BETZ, B. J. C. VAN DER HOEVEN, and H. V. LAUER, June, 1942, Page 74.
Discussion: Electrical Drives for a 110 Inch Reversing Plate Mill — Presented by C. C. WALES and A. F. KENYON, November, 1942, Page 82.
Discussion: Electrolytic Tinplate — Presented by CARL G. JONES, M. D. STONE, C. LYNN, H. P. MUNGER, C. J. DUBY, R. J. WEAN, A. L. MILTON, A. H. BRISSE, A. L. NIELSEN, and J. C. McCURLEY, February, 1942, Page 96.
Discussion: Fuel Application in Metallurgical Heating Furnaces — Presented by R. I. GUMAER, F. S. BLOOM, E. E. CALLINAN, J. F. TILTON, E. C. McDONALD, A. J. FISHER, J. W. PERCY, and O. LUTHERER, February, 1942, Page 74.
Discussion: Grounded D-c Systems for Steel Mills — Presented by F. W. CRAMER, W. A. PERRY, L. V. BLACK, I. N. TULL, H. R. MIDDLEBROOK, and H. A. TRAVERS, March, 1942, Page 71.
Discussion: Increased Production from Existing Arc Melting Furnaces — Presented by F. C. SCHOEN, L. V. BLACK, G. O. VAN ARTSDALEN, and H. D. ESTERLY, January, 1942, Page 80.
Discussion: Increased Production from Existing Billet Heating Furnaces — Presented by A. J. FISHER, HOWARD HALSTEAD, and C. M. THOMPSON, January, 1942, Page 73.
Discussion: Increased Production from Existing Plate Mill Equipment — Presented by N. C. NYE, W. M. WARDLE, H. H. ANGEL, W. G. WILSON, A. J. FISHER, and A. F. FRANZ, January, 1942, Page 77.
Discussion: Low Voltage Distribution Systems in Steel Mills — Presented by G. E. STOLTZ, H. L. WILCOX, L. L. FOUNTAIN, E. L. ANDERSON, H. G. BARNETT, and B. M. JONES, November, 1942, Page 55.
Discussion: Maintenance of Instruments and Controls in the Steel Plant — Presented by C. L. McGRANAHAN, O. J. LEONE, L. A. DEESZ, C. L. DUDLEY, W. P. HILL, L. F. COFFIN, J. L. MILLER, R. A. WEIKEL, and R. I. GUMAER, April, 1942, Page 119.
Discussion: Methods of Increasing Production of Existing Steel Plant Equipment — Coke Plants, Blast Furnaces, Open Hearths, Bessemer and Duplexing, and Mill Equipment — Presented by JOHN EVERETTS, JR., E. K. MILLER, L. E. RIDDLE, M. A. MAYERS, RUDOLPH JANATA, and L. E. FEISNER, January, 1942, Page 66.
Discussion: Modern Bloom and Billet Heating Furnaces — Presented by E. E. CALLINAN, M. H. MAWHINNEY, E. T. MORTSON, and W. H. DAILEY, May, 1942, Page 76.
Discussion: Motor Applications and Power Requirements for Strip Processing Lines — Presented by R. A. GEUDER, H. W. POOLE, R. H. ELLIS, and J. R. ERBE, September, 1942, Page 41.
Discussion: New Developments in Lubricants for Steel Plants — Presented by T. N. FRITSCH, M. RESWICK, S. C. GRIFFITH, S. J. SOROKA and R. J. GRAHAM, October, 1942, Page 61.
Discussion: Oil Filtration and Reclamation — Presented by C. E. S. EDDIE, MAURICE RESWICK, GEORGE H. KAUFFELD, JR., F. E. ROSENSTIEHL, and C. A. BAILEY, May, 1942, Page 68.
Discussion: An Organization of Fuel Department Personnel and Practice — Presented by J. L. MILLER, A. J. FISHER, C. J. WYROUGH, T. J. McLOUGHLIN, E. T. W. BAILEY, and E. E. CALLINAN, March, 1942, Page 66.
Discussion: Oxy-Acetylene Defense Developments — Presented by MARTIN J. CONWAY and J. H. ZIMMERMAN, June, 1942, Page 82.
Discussion: Performance of Various Gases in the Oxygen Cutting Process — Presented by N. C. BYE, L. F. COFFIN, F. C. SCHOEN, A. J. FISHER, M. J. CONWAY, and P. B. BETZ, July, 1942, Page 71.
Discussion: Production of Benzol Products by the Continuous Process — Presented by L. R. MILBURN, C. R. LOHREY, R. S. ERICSON, R. B. WINTER, A. R. BORDEN, and W. H. COLLISON.
Discussion: Recent Advances in the Control of Multi-Fuel Furnaces — Presented by J. R. GREEN, M. J. BOHO, and M. J. BRADLEY, September, 1942, Page 138.
Discussion: Report of Field Tests on IR Drop Compensation — Presented by F. MOHLER, A. M. MacCUTCHEON, and G. E. STOLTZ, May, 1942, Page 58.
Discussion: Scarfing High Carbon and Alloy Steels — Presented by RUSSELL HUNT, G. D. WINLACK, M. J. CONWAY, J. G. COOPER, and H. M. FLAHERTY, April, 1942, Page 34.
Discussion: Slitting — An Old Problem Modernized — Presented by R. A. GEUDER, H. W. POOLE, G. A. CALDWELL, and GEORGE KENTIS, February, 1942, Page 35.
Discussion: Some Aspects of the Proposed Steel Expansion Program Presented by E. M. SOARES, K. D. TRUE, E. C. McDONALD, ARTHUR G. McKEE, G. E. STOLTZ, M. D. HARBAUGH, F. W. JESSOP, C. G. BIGELOW, E. E. THUM' A. M. MacCUTCHEON, EMERSON FINDLEY, C. H. TATE, A. R. DAVIS, and B. W. CORRADO, January, 1942, Page 88.
Discussion: Stoker Application for Combination Firing of Boilers — Presented by L. F. COFFIN, OTTO DE LORENZI, E. W. TREXLER, L. A. DEESZ, O. P. BURR, and W. P. HILL, March, 1942, Page 78.
Discussion: Submerged Combustion Heating for Pickling Baths — Presented by PAUL LEISS, E. B. RESSLER, W. G. SEE, O. LUTHERER, H. L. ANTHONY, and L. A. KLINE, June, 1942, Page 66.
Discussion: Substitute Coatings for Tin Plate — Presented by E. W. HOPPER, CHARLES H. MANION, JOHN M. READ, E. T. LORIG, L. F. COFFIN, C. E. BROWN, W. J. HENNESSEY, J. A. HELBLING, BERNARD RAHILLY, P. N. BOSSART, W. H. MANDY, FRANK E. JACQUES, A. J. BERDIS, J. F. EDNIE, L. I. FIELD, GEORGE H. RENDELL, W. G. CRANE, LESLIE BERNICK and A. H. BRISSE, July, 1942, Page 33.
Discussion: Systematic Inspection and Maintenance of Steel Plant Electrical Equipment — Presented by F. S. WHITE, T. E. HUGHES, W. A. PERRY, E. C. BRANDT, C. L. McGRANAHAN, A. M. KRIEGER, W. A. SMILEY, A. W. McAULY, and J. J. BOOTH, September, 1942, Page 120.

Discussion: Temperature Control of Galvanizing Kettles — Presented by MARTIN J. CONWAY, HOWARD HALSTEAD, W. N. HORKO, D. LEWIS, O. B. PYLE, C. S. STOUFFER, A. J. FISHER, November, 1942, Page 69.
Discussion: The Temper Mill — Presented by J. S. MURRAY, A. F. KENYON, CHARLES H. MANION, and T. B. MONTGOMERY, April, 1942, Page 101.
Discussion: Welding in Cold Strip Processing — Presented by H. W. NEBLETT, H. H. SHAKELY, J. H. COOPER, E. B. RESSLER, J. A. REA, STANLEY GRAND-GIRARD, and C. H. JENNINGS, July, 1942, Page 53.
Dominion Foundries and Steel, Ltd. — By T. J. ESS, April, 1942, Page 37.
Dry Blast, Economic Aspects of Pre-Compression Refrigerated — Presented by R. VD. DUNNE, July, 1942, Page 56.
Duplexing, Methods of Increasing Production of Existing Steel Plant Equipment — Bessemer and — By L. P. LIAS, January, 1942, Page 60.

E

Economic Aspects of Pre-Compression Refrigerated Dry Blast — By R. VD. DUNNE, July, 1942, Page 56.
Effect of Rate of Operation in the Coke Plant — By B. J. C. VAN DER HOEVEN, June, 1942, Page 68.
Electric Welding Machines — By C. J. JENNINGS and A. B. WHITE, June, 1942, Page 50.
Electrical Applications in the Steel Industry, Special — By J. D. CAMPBELL, February, 1942, Page 78.
Electrical Drives for a 110 Inch Reversing Plate Mill — By C. J. PORTER, C. A. PRICE, and A. F. KENYON, November, 1942, Page 73.
Electrical Equipment, Inspection and Maintenance of Steel Plant — By W. A. PERRY, September, 1942, Page 113.
Electrolytic Protection of Water Systems — By PAUL S. ARMSTRONG, October, 1942, Page 34.
Electrolytic Tinplate — By M. D. STONE, February, 1942, Page 90.
Engineering for Increased Production in the Steel Industry — By R. H. WRIGHT, September, 1942, Page 123.
Existing Arc Melting Furnaces, Increased Production from — By G. A. VAN ARTSDALEN, January, 1942, Page 78.
Existing Billet Heating Furnaces, Increased Production from — By W. N. HORKO, January, 1942, Page 70.
Existing Plate Mill Equipment, Increased Production from — By A. F. FRANZ, January, 1942, Page 74.
Expansion Program, Some Aspects of the Proposed Steel — By ARTHUR G. McKEE, January, 1942, Page 82.

F

Filtration and Reclamation, Oil — By C. A. BAILEY, May, 1942, Page 61.
Firing of Boilers, Stoker Application for Combination — By OTTO DE LORENZI, March, 1942, Page 74.
Fractures, Woody — By R. K. KULP, February, 1942, Page 39.
Fuel Application in Metallurgical Heating Furnaces — By F. S. BLOOM, February, 1942, Page 64.
Fuel Department Personnel and Practice, An Organization of — By T. J. McLOUGHLIN, March, 1942, Page 61.
Furnace, Recent Advances in the Control of Multi-Fuel Fired — By V. C. VAALER, September, 1942, Page 134.
Furnaces, Fuel Application in Metallurgical Heating — By F. S. BLOOM, February, 1942, Page 64.
Furnaces, Increased Production from Existing Arc Melting — By G. A. VAN ARTSDALEN, January, 1942, Page 78.
Furnaces, Increased Production from Existing Billet Heating — By W. N. HORKO, January, 1942, Page 70.
Furnaces, Modern Bloom and Billet Heating — By M. H. MAWHINNEY, May, 1942, Page 70.

G

Galvanizing Kettles, Temperature Control of — By HOWARD HALSTEAD, November, 1942, Page 64.
Gas Cleaning, Blast Furnaces — By O. R. RICE, December, 1942, Page 66.
Gases in the Oxygen Cutting Process, Performance of Various — By P. L. BETZ, July, 1942, Page 64.
Great Lakes Steel Corporation, The Sintering Plant at — By ERNEST FULLER, May, 1942, Page 27.
Grounded D-c Systems for Steel Mills — By L. L. FOUNTAIN and H. A. TRAVERS, March, 1942, Page 68.

H

Hydraulic Equipment, Maintenance of — By G. C. PFEFFER, October, 1942, Page 43.

I

Inconel Clad Steels, Welding, Nickel, Monel and — By W. G. THEISINGER, October, 1942, Page 75.
Increased Production from Existing Arc Melting Furnaces — By G. A. VAN ARTSDALEN, January, 1942, Page 78.
Increased Production from Existing Billet Heating Furnaces — By W. N. HORKO, January, 1942, Page 70.
Increased Production from Existing Plate Mill Equipment — By A. F. FRANZ, January, 1942, Page 74.
Influence of Water on the Lubricating Value of Mill Bearing Oil — By R. P. DUNMIRE, November, 1942, Page 30.
Inspection and Maintenance of Steel Plant Electrical Equipment, Systematic — By W. A. PERRY, September, 1942, Page 113.
Instruments and Controls in the Steel Plant, Maintenance of — By R. A. WEIKEL, April, 1942, Page 115.
Insulating Oils, Maintenance of — By R. P. DUNMIRE, December, 1942, Page 42.
IR Drop Compensation, Report of Field Tests on — By G. E. STOLTZ, May, 1942, Page 51.
IR Drop Compensation on Cleaning Lines — By J. R. ERBE, December, 1942, Page 53.
Iron Ore, Pig Iron and Scrap Situation, Survey of the — By M. D. HARBAUGH, November, 1942, Page 26.
Is Maintenance and Design a Partnership? — By W. J. FLEMING, November, 1942, Page 58.

L

Lighting — A Discussion of British and American Practice, Blackout — By DAVIS H. TUCK, March, 1942, Page 81.
Lighting for Industrial Plants, Protective — By D. H. TUCK, July, 1942, Page 42.
Lighting in Wartime, Steel Mill — By J. P. DITCHMAN, September, 1942, Page 128.
Low Voltage Distribution Systems in Steel Mills — By L. L. FOUNTAIN, November, 1942, Page 50.
Lubricants for Mechanized Lubrication, Design of — By F. E. ROSENSTIEHL, March, 1942, Page 83.
Lubricants for Steel Plants, New Developments — By MAURICE RESWICK, October, 1942, Page 55.
Lubrication, Design of Lubricants for Mechanized — By F. E. ROSENSTIEHL, March, 1942, Page 83.
Lubrication, Diesel Engine — By D. N. EVANS, July, 1942, Page 38.

M

Maintenance and Design a Partnership?, Is—By W. J. FLEMING, November, 1942, Page 58.
Maintenance of Ball and Roller Bearings — By A. A. VAN PELT, October, 1942, Page 65.
Maintenance of Hydraulic Equipment — By C. G. PFEFFER, October, 1942, Page 43.
Maintenance of Instruments and Controls in the Steel Plant — By R. A. WEIKEL, April, 1942, Page 115.
Maintenance of Insulating Oils — By R. P. DUNMIRE, December, 1942, Page 42.
Manufacture of Electric Resistance Welded Pipe and Tubing — By J. S. ADELSON, August, 1942, Page 33.
Mercury Arc Rectifier vs Motor-Generator — By L. R. MILBURN, December, 1942, Page 28.
Metallurigcal Heating Furnaces, Fuel Application in — By F. S. BLOOM, February, 1942, Page 64.
Methods of Increasing Production of Existing Steel Plant Equipment — Bessemer and Duplexing — By L. P. LIAS, January, 1942, Page 60.
Methods of Increasing Production of Existing Steel Plant Equipment — Blast Furnaces — By L. E. RIDDLE, January, 1942, Page 55.
Methods of Increasing Production of Existing Steel Plant Equipment — Coke Plants — By W. T. BROWN, January, 1942, Page 51.
Methods of Increasing Production of Existing Steel Plant Equipment — Mill Equipment — By JOSEPH MALBORN, January, 1942, Page 63.
Methods of Increasing Production of Existing Steel Plant Equipment — Open Hearths — By F. C. SWARTZ, January, 1942, Page 57.
Mill Equipment, Methods of Increasing Production of Existing Steel Plant Equipment — By JOSEPH MALBORN, January, 1942, Page 63.
Modern Bloom and Billet Heating Furnaces — By M. H. MAWHINNEY, May, 1942, Page 70.
Modern Construction of A-c Motor Control — By F. A. WRIGHT, November, 1942, Page 44.
Monel and Inconel Clad Steels, Welding Nickel — By W. G. THEISINGER, October, 1942, Page 75.
Motor Applications and Power Requirements for Strip Processing Lines — By H. W. POOLE, September, 1942, Page 33.

N

New Developments in Blast Furnace Charging — By ARTHUR J. WHITCOMB, June, 1942, Page 29.
New Developments in Lubricants for Steel Plants — By MAURICE RESWICK, October, 1942, Page 55.
Nickel, Monel and Inconel Clad Steels, Welding — By W. G. THEISINGER, October, 1942, Page 75.
Non-Ferrous Bearing Metals, Developments in — By H. A. WHITE, October, 1942, Page 46.

O

Oil Filtration and Reclamation — By C. A. BAILEY, May, 1942, Page 61.
Oils, Maintenance of Insulating — By R. P. DUNMIRE, December, 1942, Page 42.
Open Hearths, Methods of Increasing Production of Existing Steel Plant Equipment — By F. C. SWARTZ, January, 1942, Page 57.
Operation of a Modern Sintering Plant, The Design and — By M. F. MORGAN, April, 1942, Page 103.
An Organization of Fuel Department Personnel and Practice — By T. J. McLOUGHLIN, March, 1942, Page 61.
Oxy-Acetylene Defense Developments — By J. H. ZIMMERMAN, June, 1942, Page 76.

P

Performance of Various Gases in the Oxygen Cutting Process — By P. L. BETZ, July, 1942, Page 64.
Personnel and Practice, An Organization of Fuel Department — By T. J. McLOUGHLIN, March, 1942, Page 61.
Pickling Baths, Submerged Combustion Heating for — By W. G. SEE, June, 1942, Page 62.
Pig Iron and Scrap Situation, Survey of the Iron Ore — By M. D. HARBAUGH, November, 1942, Page 26.
Plate Mill, Electrical Drives for a 110 Inch Reversing — By C. J. PORTER, C. A. PRICE, and A. F. KENYON, November, 1942, Page 73.
Plate Mill Equipment, Increased Production from Existing — By A. F. FRANZ, January, 1942, Page 74.
Pre-Compression Refrigerated Dry Blast, Economic Aspects of — By R. VD. DUNNE, July, 1942, Page 56.
Pressure Vessels, Alloy Steel Cladding — By H. S. BLUMBERG, October, 1942, Page 70.
Production in the Steel Industry, Engineering for Increased — By R. H. WRIGHT, September, 1942, Page 123.
Production of Benzol Products by the Continuous Process — By C. R. LOHREY, August, 1942, Page 46.
Production of Existing Steel Plant Equipment — Bessemer and Duplexing, Methods of Increasing — By L. P. LIAS, January, 1942, Page 60.
Production of Existing Steel Plant Equipment — Blast Furnaces, Methods of Increasing — By L. E. RIDDLE, January, 1942, Page 55.
Production of Existing Steel Plant Equipment — Coke Plants, Methods of Increasing — By W. T. BROWN, January, 1942, Page 51.
Production of Existing Steel Plant Equipment — Mill Equipment, Methods of Increasing — By JOSEPH MALBORN, January, January, 1942, Page 63.
Production of Existing Steel Plant Equipment — Open Hearths, Methods of Increasing — By F. C. SWARTZ, January, 1942, Page 57.
Proposed Steel Expansion Program, Some Aspects of the — By ARTHUR G. McKEE, January, 1942, Page 82.
Protective Lighting for Industrial Plants — By D. H. TUCK, July, 1942, Page 42.

R

Recent Advances in the Control of Multi-Fuel Fired Furnace — By V. C. VAALER, September, 1942, Page 134.
Reclamation, Oil Filtration and — By C. A. BAILEY, May, 1942, Page 61.
Recovery and Preparation of Steel Scrap from Steel-Making Furnace Slag and Refuse — By FRED E. ULLMAN, August, 1942, Page 27.
Rectifier vs Motor-Generator, Mercury Arc — By L. R. MILBURN, December, 1942, Page 28.
Report of Field Tests on IR Drop Compensation — By G. E. STOLTZ, May, 1942, Page 51.
Reversing Plate Mill, Electrical Drives for a 110 Inch — By C. J. PORTER, C. A. PRICE, and A. F. KENYON, November, 1942, Page 73.
Rolls, Backing-Up — By J. A. SUCCOP, September, 1942, Page 42.

S

Scarfing High Carbon and Alloy Steels — By G. D. WINLACK, April, 1942, Page 26.
Sintering Plant at Great Lakes Steel Corporation, The — By ERNEST FULLER, May, 1942, Page 27.
Sintering Plant, The Design and Operation of a Modern — By M. F. MORGAN, April, 1942, Page 103.
Skip Hoist Control, Adjustable Voltage — By F. R. BURT, August, 1942, Page 38.
Slitting—An Old Problem Modernized—By GEORGE KENTIS, February, 1942, Page 30.
Some Aspects of the Proposed Steel Expansion Program — By ARTHUR G. McKEE, January, 1942, Page 82.
Special Applications of Steel Plant Control — By H. H. ANGEL, December, 1942, Page 50.
Special Electrical Applications in the Steel Industry — By J. D. CAMPBELL, February, 1942, Page 78.
Specifications for Electric Overhead Traveling Cranes for Steel Mill Service — August, 1942, Page CS-1.
Steel Cladding and Pressure Vessels, Alloy — By H. S. BLUMBERG, October, 1942, Page 70.
Steel Company of Canada, Ltd. — By T. J. ESS, April, 1942, Page 69.
Steel Mill Lighting in Wartime — By J. P. DITCHMAN, September, 1942, Page 128.
Steel Plant Control, Special Applications of — By H. H. ANGEL, December, 1942, Page 50.
Steel Plants, New Developments in Lubricants for — By MAURICE RESWICK, October, 1942, Page 55.
Steel Scrap from Steel-Making Furnace Slag and Refuse, Recovery and Preparation of — By FRED E. ULLMAN, August, 1942, Page 27.
Steel's Bid for Victory — By T. J. ESS, September, 1942, Page 51.
Steels, Welding, Nickel, Monel and Inconel Clad — By W. G. THEISINGER, October, 1942, Page 75.
Stoker Application for Combination Firing of Boilers — By OTTO DE LORENZI, March, 1942, Page 64.
Strip Processing Lines, Motor Applications and Power Requirements — By H. W. POOLE, September, 1942, Page 33.
Submerged Combustion Heating for Pickling Baths — By W. G. SEE, June, 1942, Page 62.
Substitute Coatings for Tin Plate — By C. E. BROWN, July, 1942, Page 30.
Substitutes Prove Satisfactory in Bronzes, Tin — By J. F. PELLY and JOHN WORTH, October, 1942, Page 44.
Survey of the Iron Ore, Pig Iron and Scrap Situation — By M. D. HARBAUGH, November, 1942, Page 26.
Systematic Inspection and Maintenance of Steel Plant Electrical Equipment—By W. A. PERRY, September, 1942, Page 113.

T

Temperature Control of Galvanizing Kettles — By HOWARD HALSTEAD, November, 1942, Page 64.
Temper Mill, The — By T. B. MONTGOMERY, April, 1942, Page 90.
Tinplate, Electrolytic — By M. D. STONE, February, 1942, Page 90.
Tin Plate, Substitute Coatings for — By C. E. BROWN, July, 1942, Page 30.
Tin Substitutes Prove Satisfactory in Bronzes — By J. F. PELLY and JOHN WORTH, October, 1942, Page 44.
Trends in the Design of D-c Control — By H. L. WILCOX, November, 1942, Page 38.

V

Vessels, Alloy Steel Cladding and Pressure — By H. S. BLUMBERG, October, 1942, Page 70.
Voltage Distribution Systems in Steel Mills, Low — By L. L. FOUNTAIN, November, 1942, Page 50.

W

Water on the Lubricating Value of Mill Bearing Oil, The Influence of — By R. P. DUNMIRE, November, 1942, Page 30.
Water Systems, Electrolytic Protection of — By PAUL S. ARMSTRONG, October, 1942, Page 34.
Welded Pipe and Tubing, Manufacture of Electric Resistance — By J. S. ADELSON, August, 1942, Page 33.
Welding, Advanced Methods of Arc — By E. W. P, SMITH. May, 1942, Page 31.
Welding in Cold Strip Processing — By J. H. COOPER, July, 1942, Page 46.
Welding Machines, Electric — By C. J. JENNINGS and A. B. WHITE, June, 1942, Page 50.
Welding, Nickel, Monel and Inconel Clad Steels — By W. G. THEISINGER, October, 1942, Page 75.
Welding Process, A New Hammered Resistance — By A. L. PFEIL, August, 1942, Page 42.
Woody Fractures — By R. K. KULP, February, 1942, Page 39.
1941, Developments in the Iron and Steel Industry during — By W. H. BURR, January, 1942, Page 26.

NEWLY ELECTED
A. I. S. E.
Officers and Directors

C. L. McGRANAHAN
FIRST VICE PRESIDENT

A. G. DELANEY
DIRECTOR

W.

C. L. McGRANAHAN'S first work in the steel industry was in 1916 with the American Sheet and Tin Plate Company. He worked in various positions with that company's different plants until 1931, allowing for one year World War service. In 1931 he joined the Inland Steel Company as superintendent of the company's Indiana Harbor hot strip mill, resigning in February 1936, to take his present position as assistant general superintendent with the Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. Mr. McGranahan was graduated from Pennsylvania State College in 1916 with a bachelor of science degree in civil engineering.

J. LEDLIE MILLER has been employed in the steel industry since 1909, serving as messenger, draftsman, and in the experimental engineering department of Carnegie Steel until he joined the army, where he served overseas as a lieutenant in the heavy field artillery. Serving as fuel engineer at the Bellaire works of Carnegie from March 1919 until that fall, he returned to the Carnegie Institute of Technology where he received his degree in mechanical engineering the following year.

Mr. Miller returned to Bellaire as fuel engineer and when this plant was closed, went to the Follansbee Brothers plant in Toronto, where he was annealing department foreman and assistant metallurgist until January 1, 1925. He served as fuel engineer of the Wheeling Steel Corporation in the Wheeling district from 1925 until he went to Youngstown for Carnegie in 1928. He acted as assistant chief engineer of Carnegie-Illinois Steel Corporation in the Youngstown district from 1928 to 1936. In 1937 he was appointed assistant chief combustion engineer of Republic Steel Corporation with headquarters in Cleveland.

J. S. MURRAY was educated in the Toronto, Ohio, public schools, Carnegie Institute of Technology, and the students course at Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania. Mr. Murray entered the employ of Westinghouse in 1916, in the research and sales department. He entered consulting engineering work at Pittsburgh in 1918. In 1920 he went with the Follansbee Brothers Company as chief electrical engineer. He has supervised the production, test and application of silicon steel sheets produced by the Follansbee Steel Corporation since 1932.

FREEMAN H. DYKE graduated from Phillip Andover Academy and from the Massachusetts Institute of Technology. Mr. Dyke started in the steel business with the Wheeling Steel Corporation at their Portsmouth plant in 1920, and with the exception of three years with the Jones and Laughlin Steel Corporation he has been with Wheeling Steel Corporation continuously. After serving in several capacities in various departments, Mr. Dyke became superintendent of the blooming, bar and hot strip mills at the Steubenville plant.

J. D. JONES, chief engineer of the Youngstown Sheet and Tube Company, Youngstown, Ohio, was born and raised in Pittsburgh and was educated at Pittsburgh Academy. From the outset he was interested in steel and set out to obtain a wide range of experience in the production of steel. He has worked in steel plants in Wheeling, Chicago. Buffalo, Pittsburgh and other cities.

In 1912, Mr. Jones went to Sault Ste. Marie as chief engineer of the Algoma Steel Company. In 1916 he went to the Gary works of the Illinois Steel Company as chief engineer until the latter part of 1919, when he returned to Algoma Steel Company as general superintendent later becoming general manager and vice president. He went to Youngstown Sheet and Tube in August, 1935.

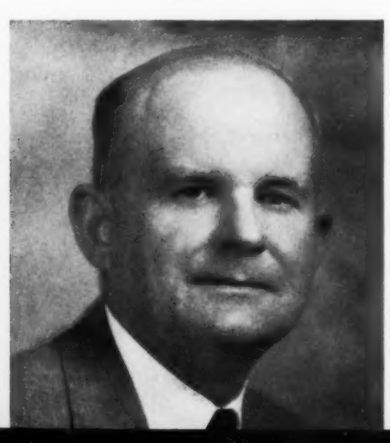
E. W. TREXLER was born in Allentown, Pennsylvania, and was graduated from Lehigh University in 1912 in mechanical engineering. From 1912 till 1917 he was employed by the Ingersoll-Rand Company at Painted Post, New York. He has been at Cambria Plant, Bethlehem Steel Company, since 1917, serving in various capacities until appointed to his present position of superintendent of the mechanical department.

H. R. ZIMMERMAN started work for the United States Steel Corporation in 1911 at the Gary Sheet Mill Plant of the American Sheet and Tin Plate Company, and successively held the positions of power foreman and electrical engineer of construction. He was later appointed to the position of assistant superintendent of maintenance, and subsequently to his present position of superintendent of the electrical maintenance department at the Sheet and Tin Mill Plant of the Carnegie-Illinois Steel Corporation, Gary, Indiana.

H. R. ZIMMERMAN
DIRECTOR

J. S. MURRAY
TREASURER

L. R. MILBURN
DIRECTOR



N. C. BYE
DIRECTOR

E. V

W. H. COLLISON
DIRECTOR

E. J. WAGAR
DIRECTOR

J. D. JONES
DIRECTOR

A. S. GLOSSBRENNER
DIRECTOR

NORMAN C.BYE, chief engineer of the Henry Disston and Sons, Inc., Philadelphia, Pennsylvania, was born in Philadelphia, and, after graduation from the University of Pennsylvania, went with the Philadelphia Electric Company. In 1918, he began work for the Disston company as combustion engineer. He subsequently served several years in the construction department and as assistant metallurgist, being appointed to his present position in 1926.

A. G. DELANEY was born in Evanston, Illinois, and studied mechanical engineering at Georgia Institute of Technology and hydraulic engineering at Ohio State University. He was a construction engineer and superintendent of construction for eight years with Dwight P. Robinson Company, working in the United States and South America. He was employed for eight years as construction engineer and superintendent of maintenance with the Gulf States Steel Company, retaining the position following the merger of that company with Republic Steel Corporation. In 1939 he was named assistant district manager for Republic at Gadsden, and in 1941 was made general superintendent.

E. J. WAGAR was born in Cleveland, Ohio, and after graduating from high school in 1922, continued his education by taking a correspondence course in mechanical engineering, later enrolling in and receiving his bachelor's degree in engineering from the evening division of Fenn College. Following high school, Mr. Wagar began work as an apprentice tool maker. He entered the employ of the Otis Steel Company in 1925 as a machinist at its Lakeside Works, and subsequently served as assistant to master mechanic, power house foreman, assistant steam engineer, and mechanical engineer. In 1937 he was promoted to the position of assistant chief engineer. Upon the merger of Otis with Jones and Laughlin Steel Corporation, he was made superintendent of the steam efficiency and combustion department of the Cleveland plant.

W. H. COLLISON was graduated from the University of Cincinnati in 1926 with a degree of chemical engineer. This was a cooperative course during which he worked in the coke plant of Pittsburgh Crucible Steel Company, beginning in 1924 and continuing after graduation until 1927. He then went to Central Alloy Steel Corporation, Massillon, Ohio, as heater in the coke plant, and was made turn foreman shortly thereafter. In 1935, Mr. Collison went with the Pure Oil Company, Marcus Hook, Pennsylvania, as a chemist. Following this he came to Detroit as boss heater for the new coke plant of Great Lakes Steel Corporation, being subsequently promoted to assistant superintendent and later to superintendent of the coke plant.

L. R. MILBURN was graduated from the University of Michigan with a degree of electrical engineering in June 1918. From July 1918 until 1919 he went with the General Electric Company doing testing, complaint, installation, and apparatus sales work. In March 1925, he moved to the Louisville Gas and Electric Company where he did construction work until October 1929, obtaining excellent knowledge of the working of a central station industry. Starting his steel mill career in October 1929 with the Great Lakes Steel Corporation as electrical draftsman, Mr. Milburn remained in this position until 1933 when he was appointed acting electrical engineer. In 1935 he was promoted to electrical engineer.

A. W. STEED was graduated from the University of Missouri with a bachelor of science degree in mechanical engineering in 1910. Mr. Steed started in the same year, 1910, with the Westinghouse Machine Company. In 1915 he joined the American Rolling Mill Company at Middletown, Ohio, where he was employed in the power department. He was made power superintendent of this plant in 1923, and in 1929 he became superintendent of maintenance, holding this position until the present time.

A. S. GLOSSBRENNER attended the University of Wisconsin and entered the steel industry about 13 years ago, in the employ of the old Illinois Steel Company, one of the predecessors of Carnegie-Illinois Steel Corporation, at the Gary tin plate plant. He was then transferred to the South Works of the same company, at Chicago, as assistant foreman. He came to the Youngstown Sheet and Tube Company in February, 1935, as assistant superintendent of the hot strip mill. About two years later he was made superintendent of the hot strip mill, and in September, 1942, was promoted to the position of superintendent of the Brier Hill plant.

E. W. TREXLER
DIRECTOR

A. W. STEED
DIRECTOR

J. L. MILLER
SECOND VICE PRESIDENT

FREEMAN H. DYKE
SECRETARY

National Committees for 1943

ASSOCIATION OF IRON AND STEEL ENGINEERS

General Chairman, Frank E. Flynn

ADVISORY COMMITTEE

Past President, A. I. S. E.

1907-1908 JAMES FARRINGTON, *Electrical Superintendent*, Wheeling Steel Corporation, Steubenville, Ohio.

1909 JOHN C. REED, *Electrical Superintendent*, Bethlehem Steel Company, Steelton, Pennsylvania.

1910 F. P. TOWNSEND, *Engineer*, Copperweld Steel Company, Glassport, Pennsylvania.

1911 L. R. PALMER, *Conservation Engineer*, Safety Department, Equitable Life Assurance Society of U. S., New York, New York.

1914 E. FRIEDLANDER, Pittsburgh, Pennsylvania.

1917 F. D. EGAN, *Electrical Superintendent*, Bethlehem Steel Company, Lackawanna, New York.

1919 D. M. PETTY, *Superintendent, Railroad Properties*, Bethlehem Steel Company, Bethlehem, Pennsylvania.

1921 E. S. JEFFRIES, *General Manager*, Universal Boring Machine Company, Hudson, Massachusetts.

1922 W. S. HALL, *Chief Engineer*, Chicago District, Carnegie-Illinois Steel Corporation, Chicago, Illinois.

1923 R. B. GERHARDT, *Chief Engineer of Construction*, Bethlehem Steel Company, Bethlehem, Pennsylvania.

1924 R. S. SHOEMAKER, *Lubrication Engineer*, American Rolling Mill Company, Middletown, Ohio.

1925 A. C. CUMMINS, *General Superintendent*, Youngstown District, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

1926 G. H. SCHAEFFER, *Electrical Engineer*, Carpenter Steel Company, Reading, Pennsylvania.

1927 *Chairman*, S. S. WALES (Retired) Box B, Westside Station, Youngstown, Ohio.

1930 F. W. CRAMER, *Electrical Engineer*, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

1931 F. O. SCHNURE, *Electrical Superintendent*, Bethlehem Steel Company, Sparrows Point, Maryland.

1932 J. J. BOOTH, *Assistant Superintendent of Maintenance*, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.

1933 J. D. DONOVAN, *Superintendent of Construction*, Arthur G. McKee Company, Cleveland, Ohio.

1935 W. H. BURR, *Electrical Superintendent*, Lukens Steel Company, Coatesville, Pennsylvania.

1936 G. R. CARROLL, *Assistant Superintendent of Maintenance*, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania.

1937 H. G. R. BENNETT, *Engineer*, Hot Rolling Mills, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

1938 L. F. COFFIN, *Superintendent*, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland.

1939 C. CLARKE WALES, Hamilton, Ontario, Canada.

1940 J. A. CLAUSS, *Chief Engineer*, Great Lakes Steel Corporation, Ecorse, Michigan.

1941 W. A. PERRY, *Superintendent*, Electrical and Power Departments, Inland Steel Company, Indiana Harbor, Indiana.

1942 T. E. HUGHES, *Superintendent of Maintenance*, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.

MEMBERSHIP COMMITTEE

Chairman: A. J. FISHER, *Fuel Engineer*, Bethlehem Steel Company, Sparrows Point, Maryland.

W. G. HOFFMAN, *Divisional Superintendent*, Sheet and Tin Mills, Carnegie-Illinois Steel Corporation, Gary, Indiana.

J. D. JONES, *Chief Engineer*, Youngstown Sheet and Tube Company, Youngstown, Ohio.

F. B. NIELSEN, *Engineer*, Tennessee Coal, Iron and Railroad Company, Birmingham, Alabama.

A. L. LEMON, *District Manager*, Reliance Electric and Engineering Company, Birmingham, Alabama.

L. A. WYND, *Electrical Superintendent*, Republic Steel Corporation, Chicago, Illinois.

A. J. WHITCOMB, *Electrical Engineer*, Freyn Engineering Company, Chicago, Illinois.

GEORGE H. ROSE, *Chief Engineer*, American Steel and Wire Company, Cleveland, Ohio.

W. W. SPANAGEL, *District Manager*, Reliance Electric and Engineering Company, Cleveland, Ohio.

F. C. FRYE, *Fuel Engineer*, Great Lakes Steel Corporation, Ecorse, Michigan.

E. F. WEISS, *District Manager*, Cutler-Hammer, Inc., Detroit, Michigan.

W. H. BEYERLE, *Assistant Electrical Superintendent*, Bethlehem Steel Company, Sparrows Point, Maryland.

L. O. MORROW, Schaff Building, Philadelphia, Pennsylvania.

C. H. WILLIAMS, *Assistant to Vice-President of Engineering*, United States Steel Corporation, Pittsburgh, Pennsylvania.

NATIONAL EDUCATIONAL COMMITTEE

Chairman: H. G. R. BENNETT, *Engineer*, Hot Rolling Mills, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

JAMES FARRINGTON, *Electrical Superintendent*, Wheeling Steel Corporation, Steubenville, Ohio.

W. A. PERRY, *Superintendent*, Electrical and Power Departments, Inland Steel Company, East Chicago, Indiana.

STANDARDIZATION COMMITTEE

General Chairman: F. D. EGAN, *Electrical Superintendent*, Bethlehem Steel Company, Lackawanna, New York.

Special committees appointed when and as required.

MEETINGS AND EDITORIAL COMMITTEE

Chairman: F. E. FLYNN, *President*, A. I. S. E.

H. R. FORD, *Chairman*, Electrical Engineering Division

F. E. KLING, *Chairman*, Mechanical Engineering Division

P. J. DOYLE, *Chairman*, Lubrication Engineering Division

S. GRAND-GIRARD, *Chairman*, Welding Engineering Division

E. C. McDONALD, *Chairman*, Combustion Engineering Division

A. C. CUMMINS, *Chairman*, Operating Practice Division

H. G. R. BENNETT, *Chairman*, Rolling Mill Division

W. H. BURR, *Chairman*, Development Report Committee

ELECTRICAL ENGINEERING DIVISION

Chairman: H. R. FORD, *Electrical Engineer*, Wheeling Steel Corporation, Steubenville, Ohio.

J. H. MILLER, *Electrical Superintendent*, International Harvester Company, Chicago, Illinois.

L. R. MILBURN, *Electrical Engineer*, Great Lakes Steel Corporation, Ecorse, Michigan.

E. L. ANDERSON, *Superintendent*, Electrical Division, Bethlehem Steel Company, Johnstown, Pennsylvania.

D. C. NELSON, *Electrical Engineer*, Johnes & Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

E. C. MARSHALL, *Chief Electrical Engineer*, Youngstown Sheet and Tube Company, Youngstown, Ohio.

T. B. McELRAY, *Superintendent*, Light and Power, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

MECHANICAL ENGINEERING DIVISION

Chairman: F. E. KLING, *Assistant Chief Engineer*, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

F. C. SCHOEN, *Assistant Master Mechanic*, Midvale Company, Philadelphia, Pennsylvania.

H. H. SHAKELY, *General Master Mechanic*, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

J. B. WHITLOCK, *General Maintenance Engineer*, American Rolling Mill Company, Middletown, Ohio.

O. A. BAMBERGER, *Mechanical Superintendent*, Republic Steel Corporation, Massillon, Ohio.

F. K. SCHEFE, *Chief Engineer*, Carnegie-Illinois Steel Corporation, Gary, Indiana.

L. J. BRAY, *Superintendent*, Machine Shop, Bethlehem Steel Company, Bethlehem, Pennsylvania.

LUBRICATION ENGINEERING DIVISION

Chairman: P. J. DOYLE, *Lubrication Engineer*, Republic Steel Corporation, Cleveland, Ohio.

R. S. SHOEMAKER, *Lubrication Engineer*, American Rolling Mill Company, Middletown, Ohio.

G. E. REISER, *Assistant Lubrication Engineer*, Bethlehem Steel Company, Lackawanna, New York.

S. C. GRIFFITH, *Lubrication Engineer*, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

W. E. HYDE, *Lubrication Engineer*, Wheeling Steel Corporation, Steubenville, Ohio.

C. E. S. EDDIE, *Lubrication Engineer*, Great Lakes Steel Corporation, Ecorse, Michigan.

H. R. GILCHRIST, *Lubrication Engineer*, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

WELDING ENGINEERING DIVISION

Chairman: S. GRAND-GIRARD, *Electrical and Mechanical Superintendent*, Sharon Steel Corporation, Sharon, Pennsylvania.

WRAY DUDLEY, *Assistant Maintenance Superintendent*, National Tube Company, McKeesport, Pennsylvania.

J. J. BOOTH, *Assistant Superintendent Maintenance*, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.

T. R. MOXLEY, *General Master Mechanic*, Wheeling Steel Corporation, Steubenville, Ohio.

N. C. BYE, *Chief Engineer*, Henry Disston and Sons, Inc., Philadelphia, Pennsylvania.

W. H. BURR, *Superintendent*, Electrical Department, Lukens Steel Company, Coatesville, Pennsylvania.

H. W. NEBLETT, *Special Engineer*, Inland Steel Company, East Chicago, Indiana.

COMBUSTION ENGINEERING DIVISION

Chairman: E. C. McDONALD, *Combustion Engineer*, Republic Steel Corporation, Cleveland, Ohio.

E. E. CALLINAN, *Combustion and Refractories Engineer*, Timken Roller Bearing Company, Canton, Ohio.

S. CHASE, *Steam Engineer*, Carnegie-Illinois Steel Corporation, Chicago, Illinois.

C. J. WYROUGH, *Superintendent*, Steam Efficiency, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

A. J. FISHER, *Fuel Engineer*, Bethlehem Steel Company, Sparrows Point, Maryland.

P. F. KINYOUN, *Combustion Engineer*, Bethlehem Steel Company, Lackawanna, New York.

E. A. HAWK, *Fuel Engineer*, Tennessee, Coal, Iron and Railroad Company, Ensley, Alabama.

OPERATING PRACTICE DIVISION

Chairman: A. C. CUMMINS, *General Superintendent*, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

W. H. COLLISON, *Superintendent*, Coke Plant, Great Lakes Steel Corporation, Ecorse, Michigan.

S. FINDLATER, *Development Engineer*, National Tube Company, Pittsburgh, Pennsylvania.

C. H. MANION, *Vice President in Charge of Operations*, Follansbee Steel Corporation, Follansbee, West Virginia.

M. K. McPHIE, *Superintendent of Furnace*, Woodward Iron Company, Woodward, Alabama.

F. S. ECKHARDT, *Chief Engineer*, Bethlehem Steel Company, Lackawanna, New York.

A. S. GLOSSBRENNER, *Superintendent*, Brier Hill, Youngstown Sheet and Tube Company, Youngstown, Ohio.

ROLLING MILL DIVISION

Chairman: H. G. R. BENNETT, *Engineer*, Hot Rolling Mills, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

J. H. CAYLOR, *Chairman Bar Mill Committee*, Republic Steel Corporation, Cleveland, Ohio.

J. A. SCHOLL, *Roll Designer*, Tennessee Coal, Iron and Railroad Company, Birmingham, Alabama.

D. L. IMMEL, *Assistant Plant Superintendent*, Copperweld Steel Company, Warren, Ohio.

F. H. DYKE, *Superintendent*, Blooming, Bar and Hot Strip Mill, Wheeling Steel Corporation, Steubenville, Ohio.

ALEX MONTGOMERY, JR., *Superintendent of Rolling*, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.

WILLIAM MORRIS, *Superintendent*, Blooming, Bar and Strip Mills, Great Lakes Steel Corporation, Ecorse, Michigan.

CONSOLIDATION OF COMPANIES AIDS MARITIME COMMISSION

▲ When the story is written of how job shop production was converted to production en masse, the story of Charles E. Moore and his Joshua Hendy Iron Works will form one of the brightest chapters.

On one of the giant craneways in the sixty acre Hendy Plant, this slogan appears: "The difficult job can be done immediately; the impossible job may take a little longer" and by this credo, Charley Moore lives, moves and has his being. Through example, he secures a like adherance on the part of every employee, regardless of the particular job. As a result, the plant flies the Maritime Commission's "M" flag and the Army-Navy"E" flag, while employees proudly wear their "E"s.

Initially assigned the task, by the Maritime Commission, of building 2,500 H.P. triple expansion steam engines for our new EC-2 freighters, the idea of producing these 271,000 pound monsters by mass production methods, instead of as individual jobs, did not cause the turn of a hair on Charley Moore's head. Starting with the purchase of the Joshua Hendy Iron Works, which was established in Sunnyvale, California, in 1856, he has put into war production the type and kind of plant facilities and organization that is truly one of the miracles of World War Two.

Reading from left to right — A. J. M. Baker, general manager, Cocker-Wheeler; C. E. Moore, president, Joshua Hendy Iron Works and George A. McKenna, general manager, Pomona-Wesco Pump Company.

This little old plant, originally built to turn out gold mining equipment in those early days of western development, had progressed to the point where it was able to turn out only about a dozen of these same big engines during the entire course of World War One. Now, the plant, expanded to cover more than sixty acres of ground, is averaging between eight and ten of these engines a week and production is going up.

In achieving engine production to keep pace with ship launchings on the west coast, there developed a number of bottlenecks in other types of necessary ship fittings and equipment, particularly in the line of steam turbines, pumps, motors and electrical control. Regardless of how good a ship's hull and engine may be and how quickly it may have been constructed, that ship cannot enter the service of supplying our navy, marine and air force stationed all over the globe until all the other accoutrements have been designed, manufactured and installed with the same precision and speed as were the hull and the engine.

The Maritime Commission recognized this fact and again called on Charley Moore, who jumped into the breach, this time purchasing the fifty-five year old Crocker-Wheeler Electric Manufacturing Compay of Ampere, New Jersey. This concern, one of the oldest and best known names in the electrical industry, already engaged in the production of motors and control equipment for the war effort, is to be greatly expanded under the management of A. J. M. Baker, a former co-worker of Mr. Moore's, when both of them were assisting in the Lend-Lease program. Mr. Baker was Deputy Director General of the British Purchasing Commission and Chief of the Machine Tool Division, while Mr. Moore

served as expert advisor to the United States Government in the allocation of machine tools. Prior to his government association, Mr. Baker was the Chief Engineer of Willys-Overland, and, before that, Chief Engineer of the Cincinnati Milling Machine Company. Through acquirement of Crocker-Wheeler Electric Manufacturing Company, Hendy expanded their line from steam engines and steam turbines to turbo-generators, motors and other electrical equipment.

This still did not meet the urge in the mind of Charley Moore to break existing bottlenecks in shipbuilding, so he gathered into the fold the Pomona Pump Company, of Pomona, California, and St. Louis, Missouri, along with its subsidiary, Westco Pump Division. Pomona, over a period of forty years, and Westco, during the past twenty-five years, have built up an enviable record of successful application of their pumps in literally hundreds of industrial usages, as well as in agriculture, municipalities and marine service. Both were possessed of huge backlogs of orders for pumps for war service, but Charley Moore needed, and therefore procured, the Pomona organization and its "know how" in the design, manufacture and application of a wide range of types and kinds of pumps.

George A. McKenna, President, chief owner and guiding genius of the Pomona Pump Company since 1924, together with the entire executive personnel, has been retained intact by Moore. In addition to the plants in Pomona and St. Louis, an entirely new twenty-five acre plant located at Torrance, California, and perfectly equipped for the manufacture of pumps has been purchased and turned over to Pomona Pump Company, Division of the Joshua Hendy Iron Works.

By these purchases, consolidations and acquirement of manufacturing and operating organizations, Hendy has made sure that when their engines, regardless of the number produced a month, go into a like number of hulls, there will be no undue delay in quickly commissioning them for service. The design and manufacture of most of the critical items required now rests securely in the hands of capable Charley Moore, while behind him is a trained organization who, through long years of experience, have acquired the know-

Tinplate Fused by Induction Heating

To make practical the final step in electrolytic tinning, which saves two-thirds the war scarce tin, Westinghouse electronic research has developed a method of high frequency induction heating to smooth the rough tin deposited on steel sheets. The electrolytic tin coating is only 30 millionths of an inch thick; the previously employed hot dip process required three times this thickness. High frequency heating is being designed to flow tin plate at speeds up to 1,000 feet per minute. The plated steel strip leaves the electrolytic bath and passes down through the inductor heater coil where, in a fraction of a second, it is heated to 450 F, the fusion point of tin. At this temperature the granular tin deposit flows into a smooth, shiny surface. The strip is cooled and the tin hardened as it next passes down through the water quench tank. Shown at this recent demonstration of a 10-inch pilot line held at the Westinghouse Radio Division Works in Baltimore are (left-to-right) H. C. Humphrey, Radio Division, Glenn E. Stoltz, Westinghouse Engineering Manager, Metal Working Section, Julius A. Clauss, War Production Board, C. F. Seyler, Jones and Laughlin Steel Company, Paul Riddle, Youngstown Sheet and Tube Company, and L. M. Gumm, Westinghouse Sales Manager, Metal Working Section.

Gun Mounts Produced for Navy

Record-breaking production of gun mounts carrying four rapid-fire anti-aircraft guns — the weapons which hurled hundreds of shells a minute at Japanese planes in the battles of Pearl Harbor, Midway and the Solomon Islands — has been disclosed by the Westinghouse Electric Elevator Company, Jersey City, New Jersey.

Large-scale manufacture of the new multiple gun units at a rate exceeding contract quota was revealed by Frank C. Reed, President of the Elevator Company, at the time of the Company's third official citation for outstanding war production. The plant received the Army-Navy "E" pennant with two stars. The new gun units are now on active duty on every type of American warship.

ledge and the ability to produce to meet the need, not only of the moment, but of the future, as well. The Hendy organization now owns and operates not only the sixty acre factory site at Sunnyvale, California, every inch of which is covered with buildings filled with equipment, but the big Pomona Plant in Pomona, its two plants in St. Louis, the Crocker-Wheeler Plant at Ampere, New Jersey, and new plants at Torrance and Long Beach, California. From all of these plants is already pouring daily a steady stream of marine engines, steam turbines, turbo-generators, motors, pumps and other equipment and ship fittings, in order to satisfy the increasingly great demand by the Maritime Commission for more and more cargo space.

FURNACE REBUILD REDUCED SEVEN DAYS

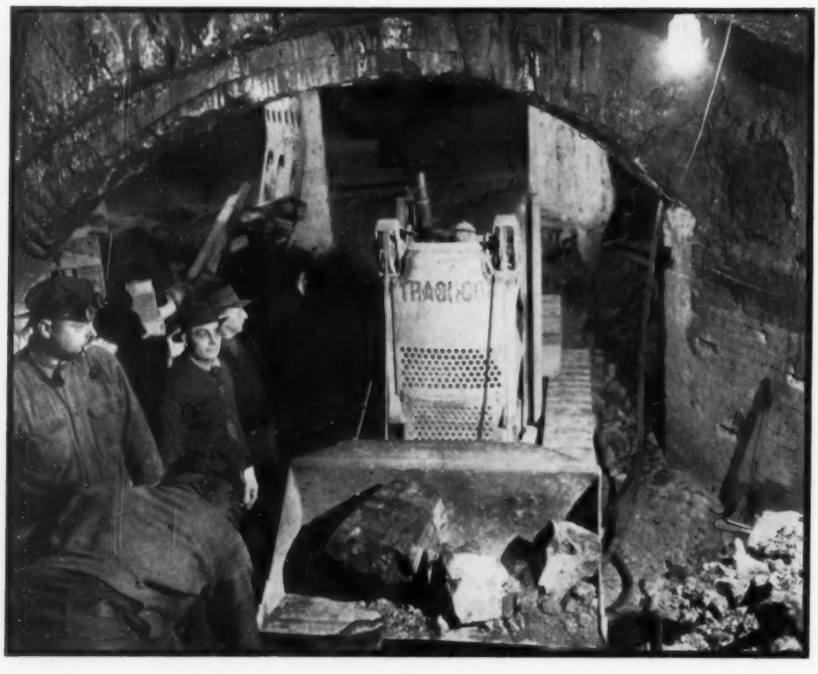
▲ The serious labor shortage recently forced Timken Roller Bearing Company to find a new solution to the problem of cleaning out open-hearth furnace slag pockets. This job normally requires the services of 30 men from 3 to 6 days and it is a laborious hand and air tool job. On a recent open-hearth furnace rebuild, six laborers were able, with a D-2 Caterpillar Tractor upon which was mounted a Traxcavator, to finish the job in 2 days. Among other things, the rapid clearing away of the broken slag by this mechanical device made it possible to break the slag loose much faster. Consequently, the furnace rebuild required only 10 days instead of 17 days and more than 1,200 tons of steel production were saved thereby.

ANNEALING OVEN CARS CONTAINS NEW FEATURES

▲ In order to facilitate the moving of annealing oven cars from loading area, to oven, to quenching tank, etc., Whiting Corporation has recently built a remarkably efficient car. It has been thoroughly tested in a progressive middle-west foundry and is highly praised by its users. A second similar car is now under construction and others are being designed for foundrymen who appreciate the advantages in operation created by cars of this type.

Into these cars are built many characteristic Whiting features of performance, economy, and safety. An ingeniously designed mechanism may be raised to engage a rack attached to the bottom of the annealing oven car. Thus, the operator, safely within an insulated steel and pyrex glass cab, can, by pushing a lever, withdraw the hot car from the annealing oven. In addition to three electrical limit switches which make accidental operation impossible, the car is protected with all possible safety devices. All operating parts are readily available for maintenance. There are no unnecessary gadgets, or trimmings — "a stout car built to do a heavy job right!"

Twelve hundred tons of steel production saved by quick rebuild job at the Timken Company.



ARMOUR CASTING PLANT PROCEEDS WITH ADDITIONS

▲ Notice has been received by Blaw-Knox Company to proceed with construction on the addition to its Union Steel castings division tank armor castings plant on which work was postponed last November. The new construction covers an extension to facilities utilized for the production of tank armor castings and when completed will permit a considerable increase in the output of this material.

MIDWESTERN STEEL FIRM AWARDED NAVY "E"

▲ The Inland Steel company recently acknowledged official word from Washington that its Indiana Harbor plant has been given the Army and Navy Production Award. No plans have yet been made for the formal presentation ceremony.

Wilfred Sykes, president of Inland, in a letter to Under Secretary of War Robert P. Patterson, expressed the company's gratification at having received the award.

"We are all proud of the many production records which have been made," he stated, "but more particularly of our sustained high productivity in spite of shortages and at times poor quality of raw materials, loss of skilled employees and other difficulties."

He added that "it is the spirit of this organization to maintain, and if possible surpass past production to the end that we all may in our own way contribute to the ultimate victory of our country.

"We will fly the flag to be conferred as a symbol of our determination to contribute our full share in this war effort."

In his letter of notification addressed to the men and women of the Indiana

Harbor plant, Mr. Patterson wrote:

"Your patriotism, as shown by your remarkable production record, is helping our country along the road to victory. May I extend to you men and women of the Indiana plant my congratulations for accomplishing more than seemed reasonable or possible a year ago?"

NEW STEEL TYPE HOLDERS FOR PRODUCTION STAMPING

▲ A product known as Champion Interchangeable steel type holders has been announced by the Jas. H. Matthews and Company, Pittsburgh, Pennsylvania. The outstanding advantage of this product is that the same holder can be quickly and easily converted for use in a press for production stamping on all types of products, or for use with a hammer depending on the marking application.

For hand stamping applications, the removable head is placed over the shank and held in place by means of a set screw, tightened at the side. For press use, the head is removed and the shank is placed into press equipment.

The Champion type holder is recommended for 90 per cent of all heavy or medium marking applications which required long, continuous hard usage. The holder can be made for any desired type capacity. For light duty marking, which includes the marking of wood, brass, and other soft materials, up to ½ in. character size is recommended. For medium duty marking, which includes marking of cold rolled steel, and carbon steel, etc. up to ⅜ in. character size is used. For medium heavy duty which includes deep marking of carbon steel or marking high alloy tool steel, up to 3/16 in. size characters are recommended.

Steel type is quickly and easily changed in the holder by applying slight pressure on a spiral spring, which disengages the spring clip from the type groove, allowing for amazingly fast type changing.

"Tuf-Face" steel type is available in letters, figures, symbols or logotype. Blank spacers must be used where full capacity of type slot is required in the marking application.

This holder recommended for heavy or medium marking applications.

COOLANT PUMPS FOR INDUSTRIAL PURPOSES

▲ A number of new coolant and circulating pumps have just been announced by Ingersoll-Rand Company. These new pumps include ¾ in. and 1 in. side-wall-mounted types, a 1¼ in. side-wall-mounted type for low-submergence applications, and a 1¼ in. horizontal type.

These new machines are additions to the line of coolant pumps previously available which include ¾ in., 1 in., and 1½ in. immersion-type pumps and a 1¼ in. side-wall-mounted-type pump.

These pumps are particularly suitable for installation on machinery requiring a coolant or circulating unit; for example, those types of lathes, drills, automatics, cut-off machines, and grinders which require a constant supply of cooling fluid or cutting oil. Other equipment for which these pumps are suitable includes evaporative condensers, air-conditioning units, washers, etc.

A new 20-page catalog covering the complete line of coolant and circulating pumps is available. It includes full descriptions, performance tables, curves, cross-sections, and dimensions. It covers pumps ranging in capacity from 5 to 150 gpm for heads up to 125 feet.

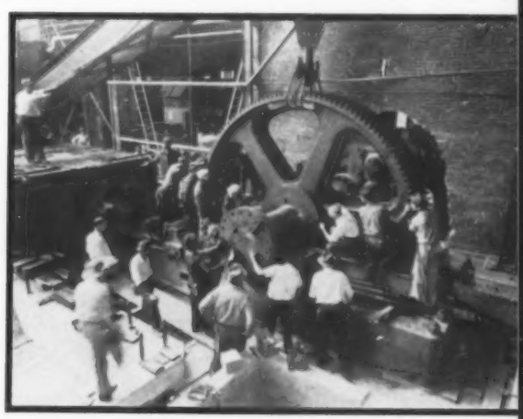
This catalog is known as Bulletin 7074 and can be obtained from Ingersoll-Rand Company, 11 Broadway, New York, or any of its branch offices.

OLD MERCHANT MILL REBUILT IN RECORD TIME

▲ Copperweld Steel Company's crews recently performed an outstanding job in setting heavy equipment on foundations as part of the job of rebuilding the entire 29-inch mill. This entire mill was removed from its foundations and completely re-built, the old foundations were dynamited, new foundations poured and the rebuilt and re-modeled mill set in place and put in operation in a period of 14 days. Under usual circumstances this job would have taken months.

This was a case where management had emphasized to the workmen the urgent need for this equipment to

Workmen set record in rebuilding mill in a period of fourteen days. Many months time was saved.



more quickly furnish steel for tanks, guns, planes and other fighting equipment so badly needed by their brothers in arms. These American workmen responded with a will and made hours equal days in a hustle-up job to get this mill set and going again.

WAR PRODUCTION FUND TO CONSERVE MAN-POWER

▲ A statement by Paul V. McNutt, chairman of the War Manpower Commission, upon the National Safety Council's inauguration of the drive of the War Production Fund to Conserve Manpower:

Since Pearl Harbor more Americans have been lost to the war effort through accidents on the home front than have been killed, wounded or captured in military and naval operations. Announced casualties in the United States armed forces since Pearl Harbor have totalled 58,307 including those missing. Casualties to American workers through on and off-the-job accidents in the same period have numbered 46,300 dead, 4,000,000 injured.

This grim accident toll is a major handicap to stabilizing American manpower. As a waste of human life and material resources it is intolerable. We know that accidents can be prevented. We know that our supply of workers is so limited that we cannot afford to lose even one through accident. Wars cannot be won by armies with a "safety first" slogan. But the war can be lost on the home front without this slogan.

Today the safety engineering profession faces a tremendous accident-prevention task. Production rates have been stepped up enormously. An army of new workers eventually to total 20 millions, including unprecedented numbers of women, older men and youths, is settling down into new jobs. Plant expansion, the crowding of war production centers, the dearth of housing, war workers transportation difficulties, the fatigues of the swing shift — all these factors contribute to the accident toll.

Several agencies of the government have been at work on the safety problem. The Division of Labor Standards of the Department of Labor through its establishment of the National Committee on the Conservation of Manpower in War Industries has done a great work in enrolling the help of hundreds of safety engineers. The Industrial Hygiene Division of the United States Public Health Service has dealt with those aspects of safety which relate to health and physical stamina. The Office of Defense Health and Welfare Service has worked for the coordination of governmental and community services concerned with the safety problems, but the government cannot do this job. It is a task for all industries and all labor and requires voluntary action.

The President has recognized the need for an expanded safety program. He has recognized the threat that accidents constitute to the effectiveness of America's manpower, and called some months ago upon the National Safety Council to aid in the mobilizing for a total war against accidents. In doing so, he paid tribute to the 31 years of experience in home traffic and industrial accident prevention.

To finance an expansion of National Safety Council facilities commensurate with the critical need, it was

CROUSE-HINDS
Type DVS
CIRCUIT BREAKER
CONDULETS
Dust-Tight, Vaportight, and Weatherproof
Type DVS Size A
For Two Single-Pole
Circuit Breakers
Type DVS
For Two or Three-Pole
600 Amp. 600 Volt AC
or 250 Volt DC
Type DVS Size B
For Six Single-Pole
Circuit Breakers
Wherever weatherproof or dust-tight enclosures are required or the conditions necessitate sturdy, protective housings, the type DVS circuit breaker Condulets are ideal. They are built to Underwriters' Laboratories' Inc., standards for Class II hazardous locations.
Thermal circuit breakers made by several manufacturers may be installed.
The type DVS Condulets illustrated at the left are arranged to take two, four, or six single-pole and two or three double-pole, 15 to 50-ampere circuit breakers. These Condulets are furnished with a terminal block on which is mounted a neutral bus-bar with wire terminals, so that the circuit breakers may be used independently or connected and used as a panelboard.
Other type DVS Condulets are available for single circuit breakers, one, two or three-pole, 15 to 600-ampere.
A Nationwide Distribution Through Electrical Wholesalers
CROUSE-HINDS COMPANY
SYRACUSE, N. Y., U. S. A.
Sales Offices: Birmingham — Boston — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit — Houston — Kansas City
Los Angeles — Milwaukee — Minneapolis — New York — Philadelphia — Pittsburgh — San Francisco — Seattle — St. Louis — Washington
Resident Salesmen: Albany — Atlanta — Baltimore — Buffalo — Charlotte — New Orleans
CROUSE-HINDS COMPANY OF CANADA, LTD., Main Office and Plant: TORONTO, ONT.

estimated that $5,000,000 would be needed. To raise this $5,000,000 by voluntary contribution from business and industry the War Production Fund to Conserve Manpower was organized by business and industrial industrial leaders throughout the United States. William A. Irvin, former president of the U. S. Steel Corporation and himself a pioneer in industrial safety, was asked to devote his executive and technical experience to the Fund. He is now busy full time as national chairman.

The National Safety Council and the Fund correctly understood their wartime assignment as a responsibility to educate the public so that safety becomes a watchword and a patriotic duty. Their concurrent task is to put into action both broad and detailed plans for the immediate reduction of accidents, an administrative task that must be supported by popular understanding. Through a nation-wide network of committees this far-reaching operation is taking shape.

Already the Council has tackled problems of wartime accident-prevention. For the Maritime Commission, safety programs have been worked out for East, Gulf and West Coast shipyards. In co-operation with the safety and security branch of the Provost Marshall General's Office, the Council is training safety personnel for introduction into plants producing for the Army. In this regard it is notable that only one out of eight American industrial establishments is today protected by an all-around safety program. For the Labor Department and the U. S. Office of Education the Council has set up safety courses and provided instructors to teach these courses to future industrial men. High school boys are being trained in safe driving, in preparation for their induction into the Army or into war industry. Safety training courses are being made an integral part of courses given in vocational and engineering schools.

Plans for car-pooling, for the staggering of working-hours and for smooth traffic routing have been worked out by the Council, and are now in use in such mushroom military-industrial areas as the Rock Island Arsenal; Provo, Utah; Decatur, Illinois; Little Rock, Arkansas; Mobile, Alabama; and other areas. In all these places the Council is collaborating with the Army and the municipal and State authorities.

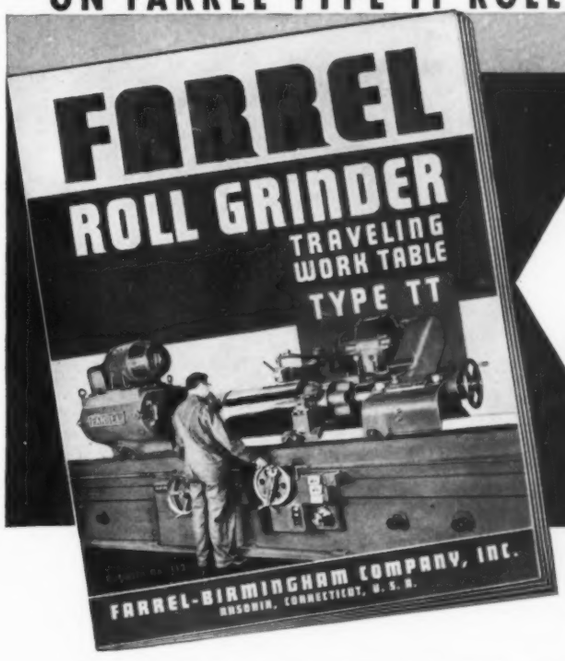
An over-all attack on the accident-problem, one that reaches outside the factory, is absolutely necessary since three out of five accidents happen off the job. All accidents — the fatality or injury strikes the housewife and the child, as well as the steelworker and the miner — have a powerful if not easily measurable effect on war time morale. It is important to note that the grand total of accidental deaths an injuries is just about double the toll on workers proper.

On the eve of a nation-wide tour by the Fund's national chairman, Mr. Irvin, of important war production centers to stimulate maximum accident-prevention, I wish to call on American business and industry for their enthusiastic support of the national safety movement. As chairman of the War Manpower Commission I feel that Mr. Irvin, the committees of the War Production Fund

MINIMUM SKILL NEEDED TO PRODUCE

High Quality Rolls

ON FARREL TYPE TT ROLL GRINDER



Send for New 32-page Descriptive Bulletin No. 113

Developed to meet today's needs for high output with a minimum of skill on the part of the operator, the Farrel Type TT Roll Grinder will grind rolls with straight, concave or convex contours to predetermined standards of accuracy and finish. A patented attachment for grinding tapers can be incorporated in the machine . . . or added after installation.

Executives responsible for the accuracy and finish of ground rolls, cylinders and shafts will find much information of value in this new booklet. Specifications, dimensions and weights are conveniently tabulated; photographs, diagrams and drawings illustrate the features of the machine. Send for your copy today . . . no charge . . . no obligation.

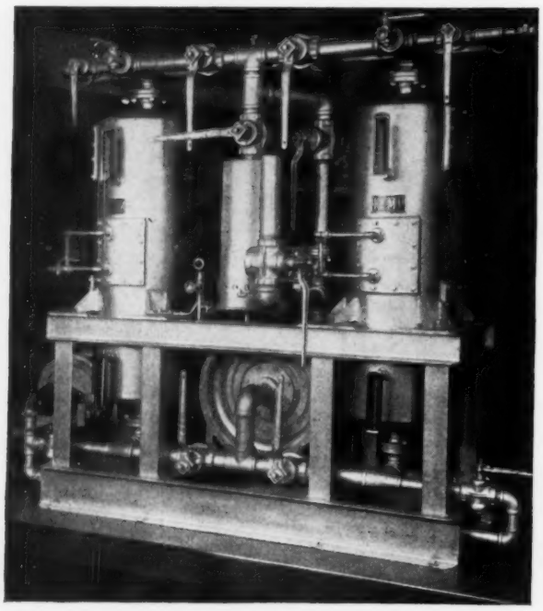
FARREL FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.
New York • Buffalo • Pittsburgh • Akron • Los Angeles

throughout the United States and the National Safety Council are to be congratulated for their timely contribution to the broad task of saving manpower for warpower. They are setting up an example of active civilian co-operation which is all-important in winning the war.

BLAST FURNACE BOOK REVIEWS MODERN PRACTICE

▲ "The Blast Furnace — Its Raw Materials, Products, By-Products and their Chemical Analysis," by R. P. Hudson, is the latest addition to the rather lean field dealing with blast furnace practice. Containing 254 pages, the book is divided into three sections: Raw Materials, Products and By-products, and Sampling and Analysis. This third section will be of particular interest to the metallurgical chemist.

The subject of blast furnace fuel is given considerable attention, and a method of calculating the furnace burden is detailed. Published by the Chemical Publishing Company, Inc., Brooklyn, New York, the book should prove of general interest to practical blast furnace men as well as to students of metallurgy and metallurgical analysis.



for DRY

ANNEALING ATMOSPHERES

KEMP SILICA GEL DEHYDRATORS guarantee the *exact* degree of dryness you need in *your* annealing atmospheres.

Designed by gas equipment engineers; and proven by an impressive record of dependable and economical operation in plants demanding constant and exact drying of annealing atmospheres.

Write **The C. M. Kemp Mfg. Company, 405 East Oliver Street, Baltimore, Maryland—ask for Dryer Bulletin.**

STANDARD UNITS BUILT TO GIVE:
Capacities: 10 to 100,000 c.f.m.
Pressures: Atmospheric to 2500 lbs. per square inch
Adsorbent: Silica Gel, high capacity, long life
Activation: By gas, electricity, or steam, as desired
Types: Single or twin towers for intermittent or continuous operation

The Army-Navy E Flag, awarded "for high achievement in the production of materials of war", proudly flies at the C. M. Kemp Mfg. Co.

KEMP of BALTIMORE

FIRST EXPLOSION PROOF FLUORESCENT UNIT ON MARKET

▲ The Appleton Electric Company, Chicago, Illinois announces the first explosion-proof fluorescent unit on the market. This new Explosion-proof fluorescent unit complies with the requirements for Class 1, Group D,

and Class 2, Group G hazardous locations. The construction completely eliminates the need for sealing fittings and accessories. A terminal block is provided to make line connections. All factory connections are made to the same block, therefore eliminating splices. Easy accessibility to lamps, starters and ballast makes replacement of same a simple operation. The reflector is non-metallic, baked white enamel finish.

AUTOMATIC CONTROL PROBLEMS DISCUSSED IN NEW BOOKLET

▲ An entirely new, 29-page catalog —"Micromax Electrical Control" — has just been issued by Leeds and Northrup Company.

Anyone who is faced with an automatic control problem — whether the controlled quantity is temperature, pH, conductivity or per cent SO_2— will be interested in this publication. It describes control equipment cap-

(*Please turn to page 121*)

All our Time, Energy
and Experience engaged in
designing and furnishing our Efficient
Blast Furnace Equipment to enable Blast Fur-
nace Operators to obtain Maximum Production, SO
Norman
Rockwell

★ ··THAT FREEDOM SHALL NOT PERISH FROM THIS EARTH ★

Picture from our 1943 calendar. Used Courtesy Brown & Bigelow Co., St. Paul, Minn.

WILLIAM M. BAILEY COMPANY *Engineers* **PITTSBURGH, PENNSYLVANIA**

BAILEY

Products and Customers

GIVING MAXIMUM PRODUCTION FOR VICTORY!

THE THERMAL GOGGLE VALVE
THE OPEN JOINT STOVE CHECKER
THE ELECTRIC PLUNGER CLAY GUN
THE DOUBLE SHAFT PUG MILL
STATIONARY WHEEL PIG CASTING MACHINE
REGENERATIVE FURNACE CHECKER
THE BAILEY MECHANICAL VALVE
FABRICATED STEEL STOVE BOTTOM
THE CINDER NOTCH STOPPER
SINTERING PLANT PUG MILL
PRECISION TABLE FEEDER
WATER METERING METHOD
BLAST FURNACE COLD BLAST VALVE
BLAST FURNACE BLOW-OFF VALVE
CHECK AND SNORT VALVE
MIXING AND CHECK RELIEF VALVE
LADLE SKULLING HOOK
GAS SEAL FOR GAUGE RODS

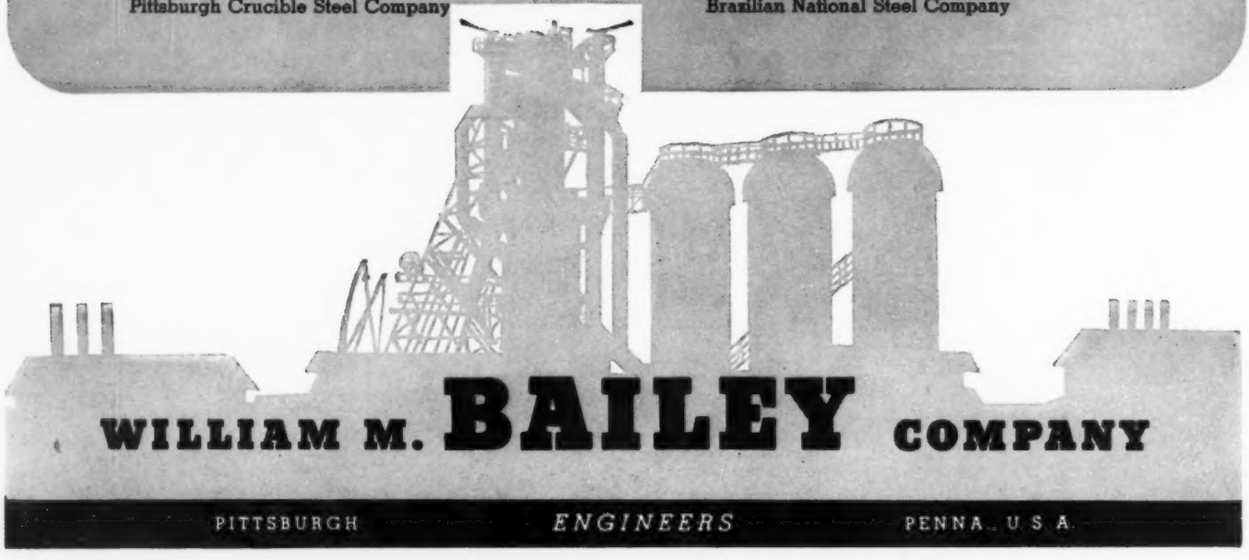
Alan Wood Steel Company
American Rolling Mill Company
American Steel & Wire Company
Bethlehem Steel Company
Carnegie-Illinois Steel Corporation
Chateaugay Ore & Iron Company
Columbia Steel Company
Ford Motor Company
Foster-Wheeler Company
Freyn Engineering Company
General Electric Company
Glass Containers, Inc.
Great Lakes Steel Corporation
Hamilton Coke & Iron Company
Hanna Furnace Corporation
Inland Steel Company
International Harvester Company
International Nickel Company
Jones & Laughlin Steel Corporation
Jackson Iron & Steel Corporation
Kaiser Iron & Steel Company
Latchford-Marble Glass Company
Lone Star Steel Company
Arthur G. McKee & Company
National Tube Company
Pittsburgh Coke & Iron Company
Pittsburgh Crucible Steel Company
Pittsburgh Steel Company
Republic Steel Corporation
Sheffield Steel Company
Sloss-Sheffield Steel & Iron Company
Tennessee Coal, Iron & Railroad Company
Toledo Furnace Company
Tonawanda Iron Company
Weirton Steel Company
Wheeling Steel Corporation
The Youngstown Sheet & Tube Company
United Engineers & Constructors

CANADA
Algoma Steel Corporation
Dominion Steel & Coal Corporation, Nova Scotia
Hudson Bay Mining & Smelting Company, Ltd.
Steel Company of Canada, Ltd.

ENGLAND AND SCOTLAND
Twenty Steel Companies in these countries use Bailey Blast Furnace Equipment

* * * *

Tata Iron & Steel Company, India
South African Iron & Steel Company
Matalloimport Magnitostroy, U.S.S.R.
Brazilian National Steel Company



WILLIAM M. BAILEY COMPANY

PITTSBURGH *ENGINEERS* PENNA., U.S.A.

European Representative: Ashmore, Benson, Pease & Co., Ltd., Stockton-on-Tees, England

able of handling any process which can be controlled by positioning a valve or other regulating device — a control which holds smoothly, surely at the control point, under either transient or sustained changes in demand.

Diagrams and text explain in detail how the equipment is adjusted to fit the needs of a particular process. And a number of pictures show the equipment in actual use in a wide variety of applications.

If you are concerned in any way with automatic control, you'll be interested in this book. And, even if you have a copy of the previous (1939) catalog, you'll want to replace it with this new one. Ask Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania, for Catalog N-00A.

▲A new bulletin on air blowers and exhausters, gas boosters, and industrial vacuum cleaning systems has been published by Allen Billmyre Corporation. The bulletin concisely describes many types of turbo and rotary blowers, and also stationary and portable vacuum cleaners for industrial plants. Copies can be obtained by writing Allen Billmyre Corporation, 431 Fayette Avenue, Mamaroneck, New York, and asking for Bulletin I-100.

PRESENT PUMP CARE REVIEWED IN BOOKLET

▲ In further recognition of the great and growing contribution of maintenance to the war effort, Allis-Chalmers, one of America's leading builders of centrifugal pumps, has just released another important maintenance manual — "Handbook for Wartime Care of Centrifugal Pumps." It is part of a series which already includes books on the wartime care of motors and V-belts.

Like motors and drives, pumps are being pushed far beyond normal capacities, and many pumps that worked 1,800 hours in a peacetime year are now working 8700 hours a year, according to Allis-Chalmers. Consequently, a new standard of pump care has been set forth in this important new handbook as a necessary solution.

Abundantly illustrated, Allis-Chalmers' new maintenance guide makes specific recommendations for putting pump care on a wartime basis. Step by step a centrifugal pump is actually built, and as each part is added, the way it is built and functions are seen to determine the way it should be cared for.

Valuable wartime tips included in the book describe: How a change in liquid can blitz a pump, easy ways to find leaks, common mistakes in packing stuffing boxes, how tight is "too tight" for a gland, how to figure head, how to protect pumps against cavitation, the vital role of water as a lubricant in pumps, quick diagnosis of pump ills, and many others.

The new manual applies to all makes of pumps and contains no advertising. Copies can be obtained free of charge by writing the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

Buy War Bonds and Preserve the American Way of Life

Are you interested in Saving

MAN-POWER
FUEL
MATERIAL
This Gage will do it!

HAYS VISIO-RATIO GAGE

IT SAVES IN MAN POWER because it eliminates the necessity of making calculations to determine air excess or deficiency—does away with lost time in making experimental adjustments.

It saves in fuel because it indicates instantly when there is an incorrect proportioning of air and fuel. It is an infallible guide to highest possible combustion efficiency.

It saves in material through producing greater uniformity in production methods, in minimizing spoilage, etc. It may be used for indicating not only the ratio of air flow to fuel flow—but the ratio between other functions such as pressure, draft, suction, temperature (up to 1000° F) speed in R.P.M. or inches per minute, position, level and others.

The cross-pointer feature is exclusive with the Hays Visio-Ratio Gage. It shows at a glance not only the amount of the two flows but the percentage of excess or deficiency existing between them.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROLS
MICHIGAN CITY, INDIANA, U.S.A.

Send for
PUBLICATION 41-478 ON CENTRALIZED CONTROL OF OPEN HEARTH FURNACES

ITEMS OF INTEREST

C. A. Thayer's appointment as consultng engineer for Republic Steel Corporation has been announced by C. M. White, vice president in charge of operations.

Mr. Thayer, who has held the position of chief engineer, is on leave of absence because of health.

R. H. Bahney, formerly assistant chief engineer, has been made chief engineer of steel plants and mines, and **F. M. Darner** has been made chief engineer of manufacturing divisions.

Mr. Bahney was born in Massillon, and started with Central Steel Company in 1915. He was made chief electrician of the corporation's Canton properties and when Republic Steel was organized in 1930, he was named assistant superintendent of mechanical and electrical departments in Canton. In 1936 he entered the engineering department and in 1939 was made chief engineer of the Central Alloy District. He came to Cleveland as assistant chief engineer in 1941.

Mr. Darner was formerly an engineer with the American Rolling Mills Company at Zanesville and Middletown, the Erie Steam Shovel Company, and chief engineer of Erie Malleable Iron Company, Erie, Pennsylvania. Mr. Darner joined Republic through Steel and Tubes Division as plant engineer at Cleveland Plant in 1933 and became chief engineer of the Division in 1934. In 1939 he was made assistant chief engineer of Republic, specializing in the manufacturing divisions.

Mr. Thayer has been chief engineer of Republic Steel since its formation in 1930.

C. W. Meyers, district manager of Republic Steel Corporation's Central Alloy District, has been given leave of absence to serve as special assistant to H. G. Batcheller, director of the Steel Division of the War Production Board. In his absence, G. W. Putnam, assistant district manager, will serve as acting district manager.

Fred B. Loveland has been appointed as assistant general superintendent of the Youngstown District plants of the Carnegie-Illinois Steel Corporation.

Mr. Loveland was first employed by the corporation at the Greenville plant of the National Steel Company, now a part of Carnegie-Illinois Steel Corporation, in June, 1906. In August, 1908, he was transferred to the Ohio Works of Carnegie Steel Company as assistant order clerk and was promoted subsequently to assistant superintendent and superintendent of the rolling mill, Ohio Works.

On September 1, 1937, he was appointed assistant general superintendent in charge of steel works, serving in this capacity until his present appointment.

Clyde Shultz is now acting as general master mechanic for the Jackson Iron and Steel Company at Jackson, Ohio.

Mr. Shultz was formerly connected with the D. T. & I. Railroad Company Shop at Jackson as general foreman for the past 15 years, prior to which he was employed at Portsmouth by the N. & W. Railroad Company.

J. M. Zimmerman, lawyer as well as veteran electrical engineer, has been named staff manager for the Pacific Coast District, manufacturing and repair department, Westinghouse Electric and Manufacturing Company.

In his new post, Mr. Zimmerman will supervise repair activities, pricing and contracts throughout the district, which includes the headquarters plant here and plants at Los Angeles, Seattle, Portland and Salt Lake City.

Mr. Zimmerman was born at Gibson City, Illinois, on December 25, 1895. He began his electrical engineering studies at the University of Iowa in 1917 and completed them at the University of Nebraska, where he received his degree in 1922. He joined Westinghouse the same year at East Pittsburgh, Pennsylvania, as a graduate student, later becoming successively a railway engineer and a maintenance engineer. Transferred to Chicago in 1927, he was employed there as maintenance supervisor at the time of his recent transfer west.

Thomas Chalmers, now vice-president in charge of manufacturing operations, Tennessee Coal, Iron and Railroad Company, will assume the duties also of vice-president in charge of raw materials. Mr. Chalmers has been operating vice president since 1935, having been with the company in various capacities since 1907.

A. B. Haswell, now assistant to vice-presidents in engineering and construction, becomes assistant vice-president in engineering and construction. Mr. Haswell came with the Tennessee Coal Iron and Railroad Company in 1912 as a draftsman, and has progressed through engineering channels becoming assistant to vice-presidents in engineering and construction on February 1, 1929.

R. E. Kirk, now general superintendent of coal mines, Tennessee Coal Iron and Railroad Company, becomes assistant vice-president in charge of raw materials. Mr. Kirk was employed by the company

R. H. BAHNEY
"new chief engineer of Republic steel plants and mines"

W. ARTHUR WHITE
"will run Kaiser plate mill"

as general superintendent of coal mines on May 1, 1936, coming from the Pennsylvania coal fields.

J. M. Spearman, formerly general superintendent of Fairfield Steel Works, Tennessee Coal Iron and Railroad Company becomes assistant vice-president in charge of manufacturing operations. Mr. Spearman was employed as a steam engineer on January 1, 1916 and has progressed through the various mills of the company having been made general superintendent of Fairfield Steel Works on April 1, 1937.

J. J. Phifer, formerly assistant general superintendent of Fairfield Steel Works, Tennessee Coal Iron and Railroad Company, has been advanced to the position of general superintendent. Mr. Phifer joined the company in 1938, after eighteen years employment with the American Steel and Wire Company. He attended Lehigh University.

Dudley Vaughn, superintendent of the open hearth department of Fairfield Steel Works, Tennessee Coal Iron and Railroad Company, was named as assistant general superintendent of the works. A native of Birmingham Mr. Vaughn has served the company since 1911.

W. Arthur White has been appointed plate mill superintendent for the Kaiser Company at Fontana, California. Mr. White was born in Coatesville, Pennsylvania, and entered the steel industry with the Worth Steel Company of that city. He then was associated with Donner Steel Company, returning in 1919 to Worth at Claymont, Delaware, where he spent ten years, rising from roller on the plate mill to assistant superintendent. From 1930 to 1935 Mr. White was with Republic Steel Corporation as mill superintendent and in other capacities, changing then to Otis Steel Company, where he served in the engineering department. In 1940, he went with Steel Company of Canada, Limited, at Hamilton, serving as superintendent of that company's new plate mill until the present appointment.

Obituaries

Frank C. Winters, manager of the Cincinnati office of The Electric Controller and Manufacturing Company, died in that city January 10th. He was 39 years old. After graduation from New York University Mr. Winters was first employed by the Philadelphia Electric Company before joining the Electric Controller and Manufacturing Company in 1929. He was in Philadelphia and Baltimore for Electric Controller and Manufacturing Company before assuming charge of the Cincinnati district.

Wesley R. Tinker, president and treasurer of F. Tinker and Sons Company, Pittsburgh, Pennsylvania, died in that city on December 9th at the age of seventy years.

Mr. Tinker became actively engaged in the year 1889 with the development and manufacture of solid steel shear knives being associated with Samuel Trethewey and Company Limited shortly after the formation of this company in the year 1883, and continued to take an active part in this type of manufacturing with the original company and its successor F. Tinker and Sons Company until the time of his sudden death.

MODERN BEARINGS
for MODERN NEEDS
On Roll Necks, Universal Couplings, Spindle Carriers, Table Rolls, Cranes and other tough jobs the many types of GATKE Fabric Bearings offer mighty aid in eliminating delays and avoiding costly machine shop work. An installation on your toughest service will show you. Write for particulars.
Gatke MOULDED FABRIC Bearings
GATKE CORPORATION - 228 N. La Salle - CHICAGO

Davis Thomson, formerly vice president in charge of operations, Great Lakes Steel Corporation has been appointed to a similar position with Phoenix Iron Company, Phoenixville, Pennsylvania, succeeding Malcolm Farmer, who recently resigned as executive vice president. He also succeeds Mr. Farmer as a director.

L. E. Stephens, superintendent 48 in. hot strip mill, Tennessee Coal Iron and Railroad Company, Birmingham, Alabama died on December 10, 1942. Mr. Stephens was first employed by the U. S. Steel Corporation in October 1927 as assistant roller, hot strip mill, Gary tin mill, Carnegie-Illinois Steel Corporation. He was later promoted to roller, and was turn foreman there until July 1937 when he was transferred to the Tennessee Coal Iron and Railroad Company as superintendent of the hot strip mill at the Fairfield works.

David W. Hopkins, secretary and director, R-S Products Corporation, Philadelphia, has been elected vice president. He will continue in charge of the company's Valve Division.

John S. Morris has been appointed methods engineer, By-Products Steel Corporation, Coatesville, Pennsylvania, subsidiary of Lukens Steel Company. Prior to joining Lukens as assistant consulting engineer of the new facilities program a year ago, Mr. Morris was assistant general manager, Steel Division, Alan Wood Steel Company.

Leonard T. Blaisdell, commercial vice president for General Electric Company at Cleveland, was given an honorary degree of electrical engineer at the winter graduation of Case School of Applied Science, Cleveland, in recognition of his "long and distinguished professional record." Mr. Blaisdell has been manager since 1939 of General Electric activities in the East Central district.

K. C. Gardner, vice president, United Engineering and Foundry Company, has been appointed to the additional office of general manager of the company.

This appointment was deemed advisable due to the increased activities and considerable expansion of the company's facilities.

Mr. Gardner has been associated with United Engineering since its inception in 1901, a director since 1911 and vice president since 1928.

n·B·M BRONZE AND COPPER CASTINGS

Blast Furnace Copper Castings • Roll Neck Bearings • Housing Nuts • Machinery Castings • Acid Resisting Castings • Phosphorized Copper • Locomotive and Car Journal Bearings • Babbitt Metals

NATIONAL BEARING METALS CORP.
ST. LOUIS • PITTSBURGH • NEW YORK

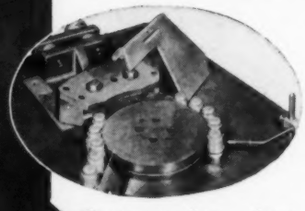
Unseen BUT Effective

The De Laval-IMO pump within the oil reservoir here shown is driven by the 7200 rpm. motor to supply pressure oil for hydraulic controls. The simplicity, compactness and lightness of the IMO pump, as well as its high efficiency, recommend it for many uses where rotary pumps are desirable but have heretofore proved too cumbersome. The IMO is also used as an hydraulic motor. Ask for Publication 1-97.

IMO PUMP DIVISION
of the De Laval Steam Turbine Company, Trenton, N. J.

FUSE MARKING
with Matthews No. 201 Machine

All required data is marked on fuse bodies, fuse parts, or other round pieces with this fast production machine. Practically all sizes and models of fuses can be marked.



The insert, above, shows a close-up of how fuse parts are marked. Parts are carried around on the pressure dial table and are quickly and legibly marked when rotated between dial and steel type holder. Write for literature.

JAS. H. MATTHEWS & CO.
3982 Forbes Street, Pittsburgh, Pa.
Branch Plants: NEW YORK, BOSTON, CHICAGO, NEWARK, PHILADELPHIA, SYRACUSE
District Sales Offices: DETROIT, HARTFORD, CLEVELAND, BIRMINGHAM

Here's one way to pinch the Axis!

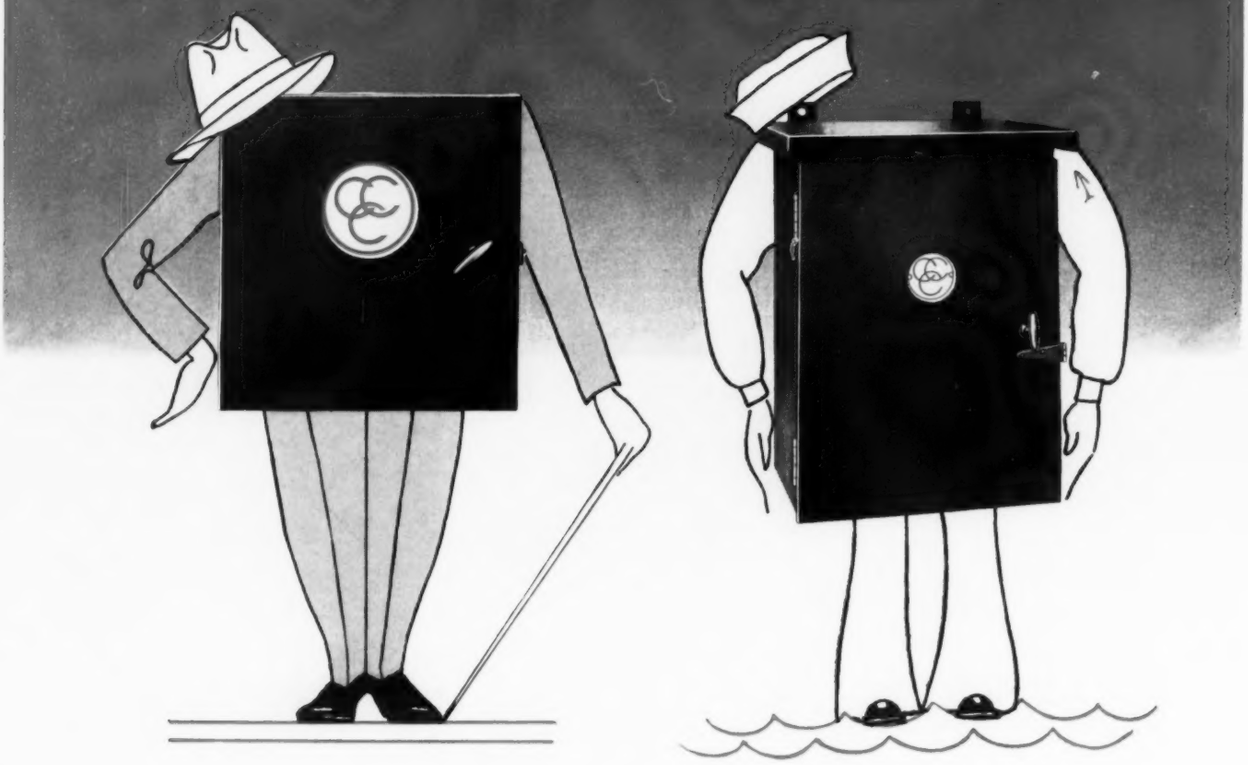
"We got a big Pincers Movement right here: hundreds of tons riding along on a film of oil no thicker than this sheet of paper!

"You know, there's an idea there! War's a pretty big thing, but it's won by having a lot of little things working right, like these Morgoils. Take my job: I watch gauges and turn valves and press buttons that keep this mill rolling steel fast!

"Maybe it's a little job, and maybe it ain't!"

MORGAN CONSTRUCTION COMPANY • WORCESTER, MASS.

"3C" STARTERS GO TO SEA!



Clark Bulletin 5370 D. C. Heavy Duty Automatic Starters, long standard in Steel Mill and heavy Industrial applications, are now adapted to life on the Ocean Wave. Just a few changes, and "3C" apparatus goes to sea!

STANDARD FEATURES		OCEAN GOING FEATURES
Dust Proof Enclosing Cabinet	◄——►	Drip Proof Enclosure
Overload Protection	◄——►	Overload Protection
Standard Finished Parts	◄——►	Corrosion Resisting Parts
Bul. 7400 DC Contactors	◄——►	Bul. 7400 DC Contactors counterweighted to prevent accidental opening or closing when ship is in high seas.
Control circuit fuses optional	◄——►	Control circuit fuses standard
Monson slate mounting	◄——►	Ebony Asbestos mounting
Bul. 110 or 113 Starting Resistors	◄——►	Bul. 110 or 113 Starting Resistors
No Disconnect Switch	◄——►	Disconnect Switch optional

"3C" Control is available for various deck auxiliary equipment as well as Bul. 5370 motor starters.

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

Timken Bearings speed up steel production for war needs—reduce costs against post-war possibilities. It will pay you to put more and more of them in your rolling equipment—from roughing mills to tension reels. Redesign now.

Help Assure Victory

Buy War Bonds. Conserve Rubber. Eliminate Unnecessary Travel. Use the Telephone Only When Important. Salvage All Scrap and Waste Material.

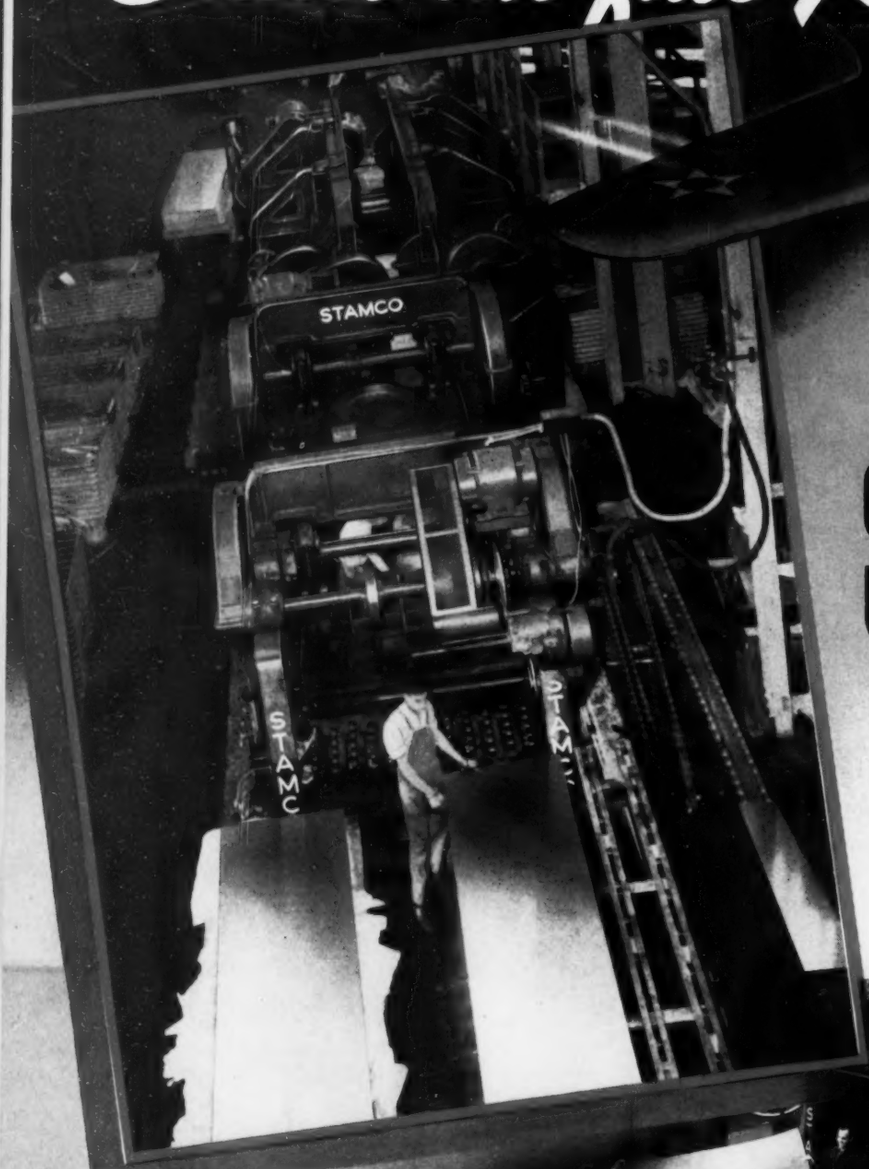
All Timken Bearing production now goes into fighting machines. However, the Timken Bearings in your motor vehicles or industrial machines will see you through the emergency—and beyond it—if you make sure they are lubricated and inspected regularly.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

Build 'em fast America!



ALCOA's rapidly increasing output of sheet aluminum for aircraft production has been facilitated by

STAMCO
SHEARS

For Accuracy, Production and Economy Use Stamco Automatic Shear Lines.

LAY YOUR SHEARING PROBLEMS AT STAMCO'S DOOR

The STREINE TOOL & MANUFACTURING COMPANY

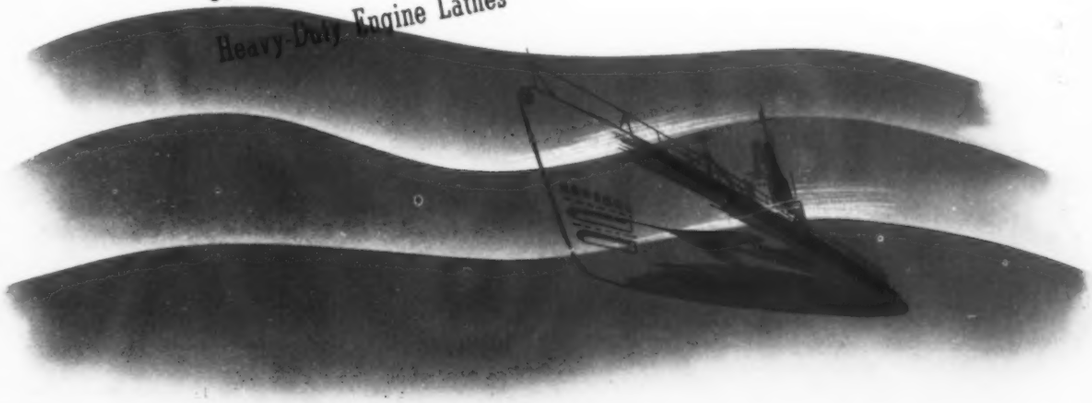
NEW BREMEN, OHIO U.S.A.

The Rolls With the Red Wabblers

"Techni" Process Rolls for four-high
hot and cold mills
give greater production
at lower cost;
they're made of enriched pure alloy steel,
especially heat treated
to produce required hardness of body surface,
well-tempered, tough to resist spalling,
journals are soft and strong.
Since 1803—Pioneers, Engineers & Builders.
Mackintosh-Hemphill Company,
Pittsburgh & Midland, Pennsylvania.
Other Mackintosh-Hemphill Products:
Rolling Machinery . . . Shape Straighteners
Strip Coilers . . . Shears . . .
Levellers . . . Pinions . . . Special Equipment . . .
Iron-Steel Castings . . .
The NEW Abramsen Straightener . . .
Improved Johnston Patented
Corrugated Cinder Pots and Supports . . .
Heavy-Duty Engine Lathes

strong to withstand stresses

"Techni"
Process
Back-up Rolls



INDUSTRIAL EXECUTIVES!

THE SCRAP FROM YOUR PLANTS IS NEEDED AT ONCE TO KEEP WAR PRODUCTION MOVING!

YOU know that all our furnaces and mills must be kept working at top speed to win this war. Yet the steel industry, already producing record quantities, cannot attain its full, needed war-time capacity of 90,000,000 tons unless 6,000,000 additional tons of scrap steel is uncovered promptly.

This critical situation can be solved only by the patriotic cooperation of every American manufacturer.

In your plant, lying around in repair shops and storerooms, is the scrap America needs to give our boys the fighting tools they must have to win . . .

Broken castings, pipe, obsolete machinery, abandoned line shafting, pulleys, pumps, old boilers, storage tanks, beams, rails, fencing, track, chains, cable, rusty bolts, nuts, and rivets . . .

Round them up and get them moving to the front!

. . . Like the gas appliance manufacturer who searched his plant and found 90 tons of scrap metals . . . or the paper mill that "mined" 1,800 tons of steel from its plants . . . or the rubber company that asked its foremen to "stop holding things" and collected 1,608 tons of iron and steel from old molds and obsolete machinery in a single week!

What others have done, you can duplicate. Walk through your plant with "Scrap" in your mind—you'll be amazed at the harvest. But get it into the fight, *at once* . . . the war won't wait!

★ ★ ★

HERE'S WHAT TO DO... Appoint one man as Salvage Manager for your organization. Give him authority to *act*—to condemn old equipment, to move material, to collect scrap of all kinds. Have him separate all scrap by type. Then move it promptly through your regular scrap dealers. Don't wait — start rounding up scrap *now* — and keep your scrap moving until the war is won!

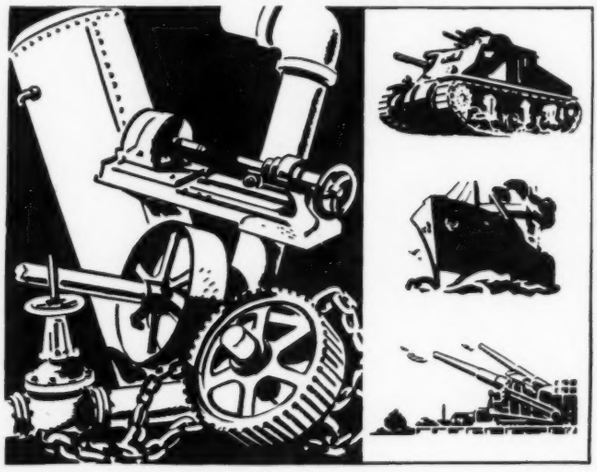
THROW YOUR SCRAP INTO THE FIGHT!

DONALD M. NELSON
says to all industry:

"The shortage of scrap materials for war production is acute. 6,000,000 extra tons of scrap iron and steel alone are needed this year, and vast quantities of rubber, copper, brass, tin, lead and zinc. Without your immediate, active cooperation — whether you have war work or not—we cannot lick this problem. We urge you to organize at once an all-out collection drive in your plants for these materials."

SCRAP NEEDED FOR WAR

SCRAP IRON AND STEEL



50% of every tank, ship, and gun is made of scrap iron and steel!

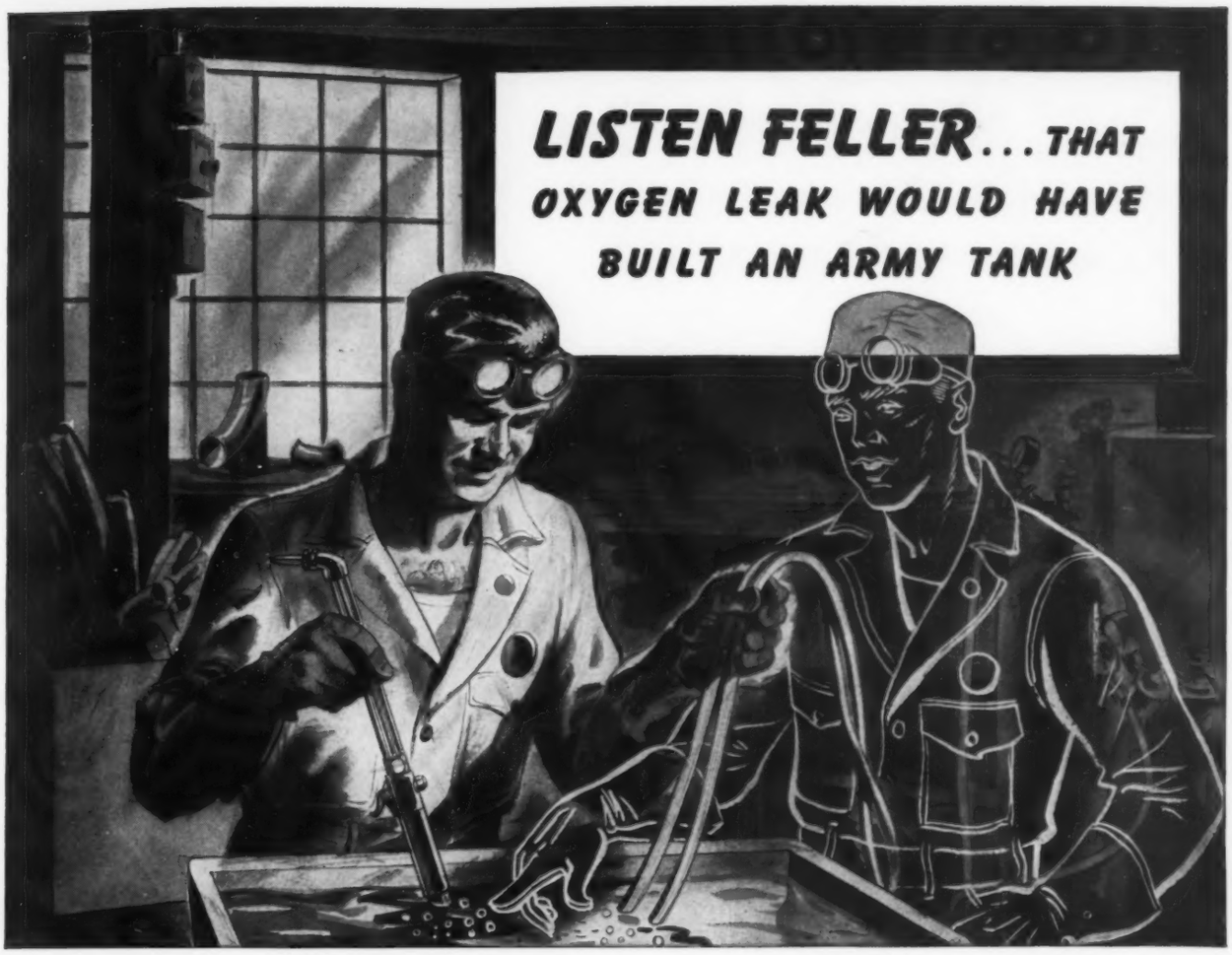
Other metals—Rubber—Rags—Manila rope—Burlap bags

Thousands of tons of these materials are needed to make bombs, tires for jeeps, surgical supplies for military hospitals, wiping rags for guns, insulation for electric wiring, parachute flares and sandbags.

This message approved by Conservation Division

WAR PRODUCTION BOARD

This advertisement paid for by the American Industries Salvage Committee (representing and with funds provided by groups of leading industrial concerns).



REPAIR ALL LEAKS IN HOSE AND CONNECTIONS

One leak as small as 1/64" in hose operating at 100 pounds pressure wastes 290 cubic feet of oxygen in 24 hours. It wouldn't take many days to waste enough to build an army tank.

That's why it is so important to conserve oxygen. Be on guard against these wasteful leaks — fix them promptly when they occur. In addition, do the following at regular intervals:

1. Inspect hose for leaks by immersing it in water — leaks occur most often near connections to regulator and torch.
2. Cut away bad portions of hose and splice good lengths together.
3. Use soap suds to check torches and regulators for leaks at connections.
4. And always send defective apparatus to repair shop for inspection and repair.

Be your own Waste Warden! Each additional cubic foot of oxygen saved means additional oxygen for war production.

THE WASTE WARDEN *says:*

DO close cylinder valve after use.
DO check your hose and connections for leaks.
DO keep your cylinder inventory low and return empties promptly.
DO keep tips clean and free from carbon and slag.

★ ★ ★

DON'T use excessive pressure.
DON'T use oversize tip.
DON'T leave torch burning when not in use.
DON'T abuse cylinders.

Air Reduction

General Offices:
60 EAST 42nd STREET, NEW YORK, N. Y.
IN TEXAS
MAGNOLIA-AIRCO GAS PRODUCTS CO.

AIRCO

WILSON

OXYGEN IS PRODUCTION — *Don't Waste it!*

READY-POWER

EQUIPPED ELECTRIC TRUCKS

Gas-Electric
POWER
PLANTS
for
ELECTRIC TRUCK
OPERATION

CONTINUOUS POWER

READY-POWER (Gas-Electric) Units on *new* or *existing* electric truck equipment handle more loads per hour per day and per year than the same equipment battery powered. This means a saving in time as well as a saving in money by accomplishing a given amount of work in less time at a lower cost per ton handled. Since 1924, thousands of Ready-Power Units have been adapted by industry to their toughest jobs. READY-POWER'S reliability and superior performance have been proved. Ask for literature.

PEAK PERFORMANCE

READY-POWER today serves industry *better*, more *completely*, than ever before with power units that cover the range of trucks from 2000 to 60,000 pounds rating. READY-POWER manufactures a complete line of Gas-Electric Power Units—*not complete trucks*. You can secure *new trucks* complete with READY-POWER from truck manufacturers or you can get READY-POWER units to replace batteries for trucks now in operation in your plants.

Write for information, mentioning type of new trucks contemplated or make and type of trucks now being operated.

MORE PER DAY PER YEAR ★ MORE WORK IN LESS TIME ★ HANDLES MORE LOADS MORE QUICKLY

Get *Wartime Power* for your NEW or PRESENT Trucks

THE READY-POWER CO.

3845 GRAND RIVER AVENUE ★ DETROIT, MICHIGAN, U. S. A.

These 2 Words

MAKE MOTOR-DRIVE *More than* POWER!

Reliance men skilled in Application Engineering start daily on new missions essential to making our great war machine produce more than we ever dreamed was possible. They are answering calls where *motor-drive must be more than power.* These are typical . . . A new tinning process to make our reduced tin supply go three times as far . . . A drive to simplify machine design and insure a top-notch production pace on a hurry-up lot of hundreds of boring mills for producing tank turrets . . . Motors to speed up production of shell-turning lathes . . . A motor-drive for an automatic towing machine that will aid sea-going tugs to handle tows with less strain and reduce chances of losing the tow . . . A hoisting motor for bringing seaplanes to a warship's deck safely in rough seas...These and many more like them are engineering jobs done in cooperation with men who *start* their design with the question, *"What can we get the motor to do besides supply power?"* Such as:

Motor-drive provides within itself a means of:

SPEED CONTROL	REVERSING
BRAKING	REMOTE CONTROL
TANDEM OPERATION	CONTROLLED ACCELERATION
TENSION CONTROL	SAFETY

SLOW SPEEDS FOR INCHING, THREADING, INSPECTION

Applying them to boost production and improve quality is APPLICATION ENGINEERING. That's our business.

Fully-enclosed, Fan-cooled D-c. Reliance Motor

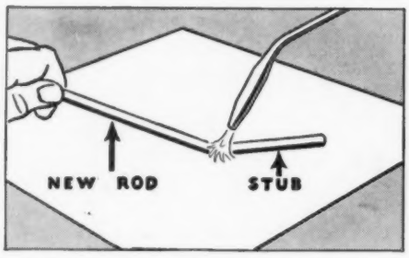
Fully-enclosed, Fan-cooled A-c. Reliance Motor

RELIANCE ELECTRIC & ENGINEERING COMPANY
1088 IVANHOE ROAD • CLEVELAND, OHIO
BIRMINGHAM • BOSTON • BUFFALO • CHICAGO • CINCINNATI
DETROIT • GREENVILLE, S.C. • HOUSTON, TEX. • LOS ANGELES
MINNEAPOLIS • NEW YORK • PHILADELPHIA • PITTSBURGH
PORTLAND, OREGON • ST. LOUIS • SAN FRANCISCO
SYRACUSE, N.Y. • AND OTHER PRINCIPAL CITIES

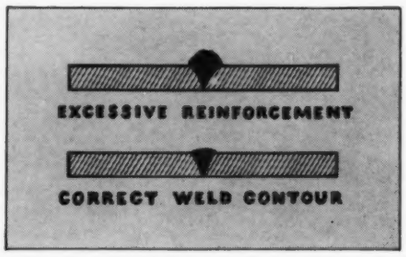
RELIANCE A-C D-C MOTORS

Make Every Effort to Conserve Oxy-Acetylene Welding Rods

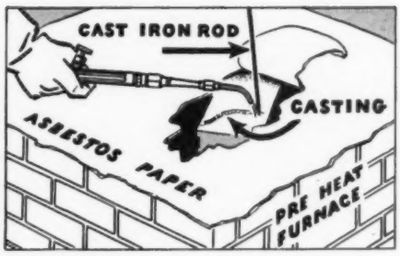
Welding rods, like all products made of materials that are strictly rationed, are subject to certain limitations of manufacture and sale. This is particularly true of rods that are made of bronze, copper, or alloy steels. In order to assure continued adequate amounts of these rods for war production, it is necessary for everyone to make every effort to conserve welding rods to as great an extent as is possible. Outlined here are some suggestions to help you to do this.



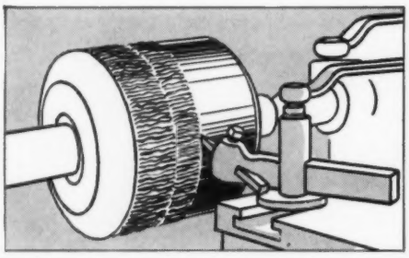
1. *Use up Stub Ends* of welding rods. This can be done by tacking them to the ends of new rods as work progresses, or by providing a container into which they can be placed for subsequent joining.



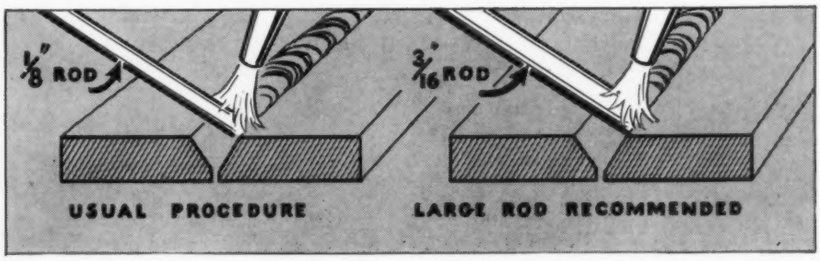
2. *Avoid Excessive Reinforcement* of the weld. Excessive reinforcement not only wastes welding rod, but also tends to set up strains and stresses in and around the weld which actually will weaken the joint.



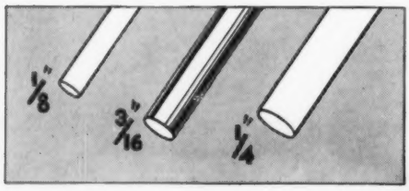
3. *Don't Use Bronze Rod* for work on which steel or cast iron rods will do the job. Of all the many types of welding rod, the bronze rods are most important to conserve. A cast iron repair job is shown above.



4. *When Depositing Bronze Rod* for resurfacing worn areas which are subsequently to be machined, hold the bronze deposit to minimum tolerances. This will prevent waste of both bronze and machining time.



5. *Use Larger Rod Sizes* whenever possible. Large rods are more readily available than the smaller sizes, because there is less call for them and because they tax the production facilities of rod mills less than does an equal tonnage of rods of smaller diameter. By working a little faster and with a slightly larger flame, a rod of larger diameter can be used with equally as good results as though a rod of the customary size were used.



6. *Reduce the Number of Rod Sizes* when ordering rod. If, for example, you normally order rod in sizes 1/8 in., 3/16 in., and 1/4 in., perhaps you can operate equally well by eliminating the 1/8 in., and 1/4 in. sizes. When the rod sizes you normally require are not readily available, use what you have or can get. This avoids delays and reduces the amount of rod tied up in inventory.

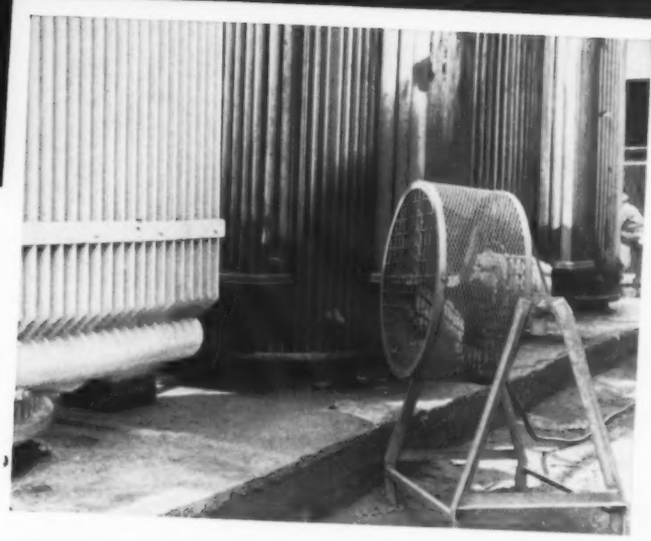
7. *Send for Reprints of This Page* for distribution in your shop. Your operators and supervisors can use them as "check lists" to make sure everything possible is being done to avoid waste of materials. We also will be glad to supply colored posters for posting on your bulletin boards to remind employees of the vital need for prompt return of empty oxygen and acetylene cylinders.

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York Offices in Principal Cities
In Canada: Dominion Oxygen Company, Limited, Toronto

Let *Truflo Fans* . . .

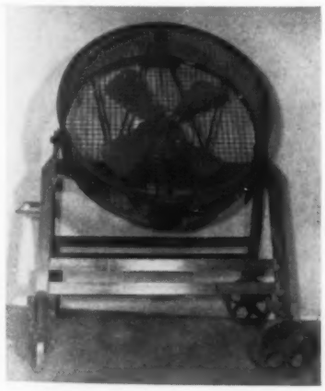
Help keep your workmen on their toes

Portable Fan No. TF-100, recognized as standard in many of the country's largest mills. Sizes from 12 in. to 36 in. in diameter.



Portable Fan No. TF-300 in operation, cooling large transformers in strip mill.

Crane Cab Fan, for cooling crane cab interiors and other confined areas. Available in 12 in. and 18 in. sizes, adjustable both horizontally and vertically.



Portable Fan No. TF-300W. Angle iron support adjusts for vertical or horizontal discharge through almost 360°.

It's more important now than ever before to keep your workmen comfortable. For comfortable workmen are more efficient, produce more work in a given time.

Truflo Fans can help you keep your workmen on their toes. All Truflo Fans are designed and built correctly for efficient, economical operation — they move more air per dollar. Write for free literature on any of the following styles:

Portable Cooling Fans • Crane Cab Fans
Wall Fans • Exhaust Fans • Blowers
Roof Ventilating Fans • Pent House Fans

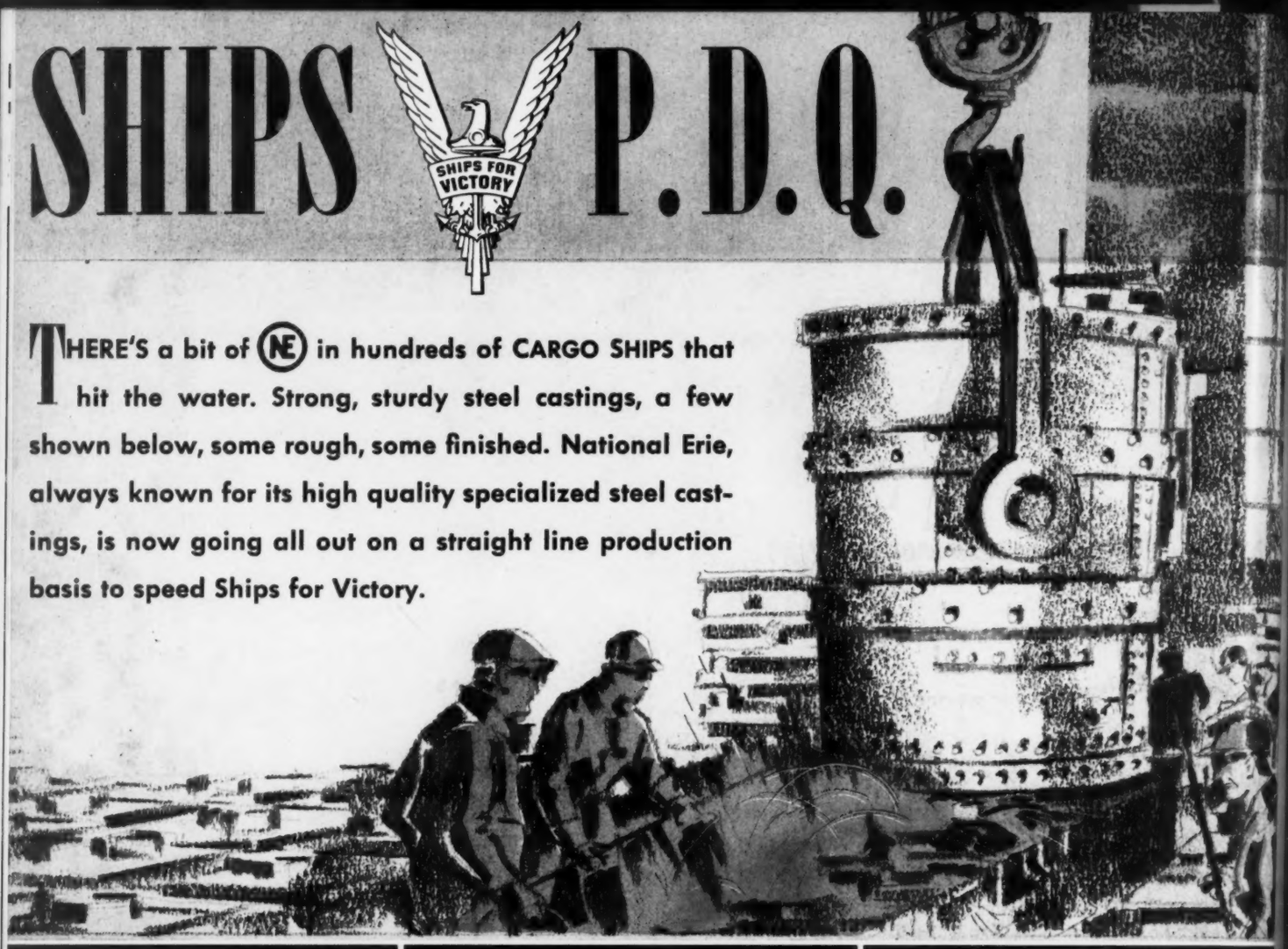
TRUFLO FAN COMPANY

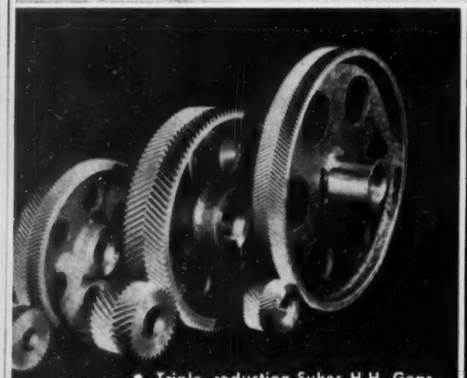
554 MAIN STREET HARMONY, PA.

SHIPS P.D.Q.

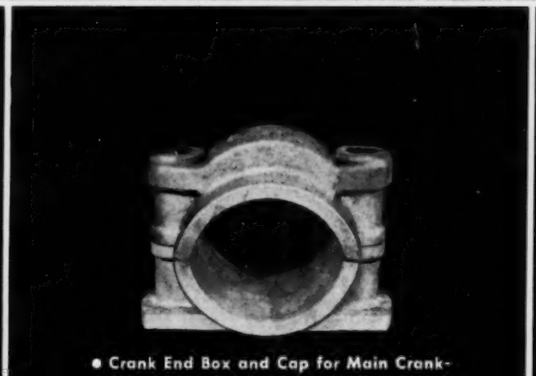
SHIPS FOR VICTORY

THERE'S a bit of NE in hundreds of CARGO SHIPS that hit the water. Strong, sturdy steel castings, a few shown below, some rough, some finished. National Erie, always known for its high quality specialized steel castings, is now going all out on a straight line production basis to speed Ships for Victory.

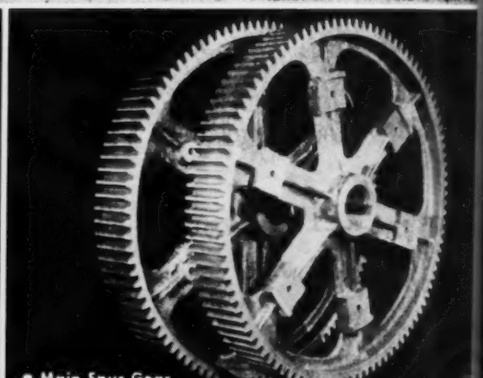




• Triple reduction Sykes H.H. Gear Drive for Two-Speed Cargo Winches



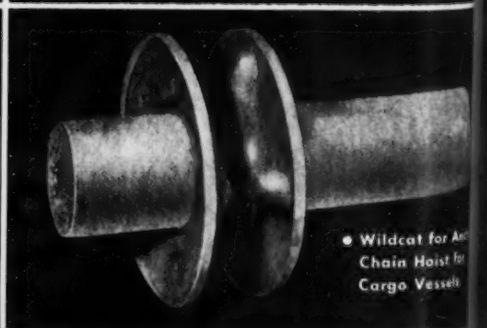
• Crank End Box and Cap for Main Crankshaft Bearing of Engines in the Liberty Ships



• Main Spur Gear in Steam Winches for Cargo Vessels

• Water Cylinder for Powder Press

• Cleats for Cargo Vessels



• Wildcat for An Chain Hoist fo Cargo Vessels

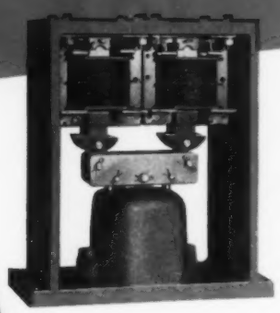
NATIONAL ERIE CORPORATION

ERIE, PA. U. S. A.

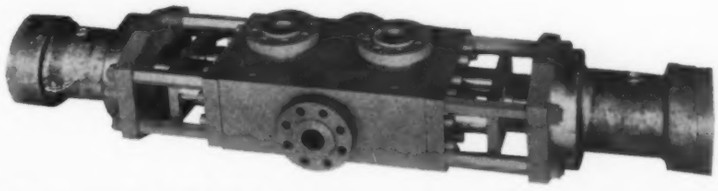
The Insignia of Quality

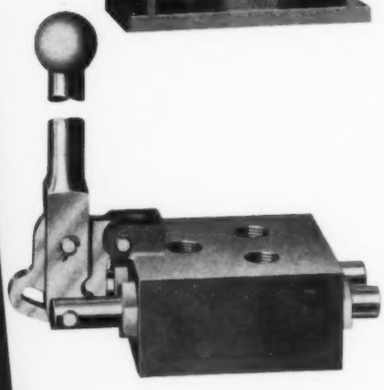
Quick-As-Wink Valves

FOR THE STEEL INDUSTRY



FOR COILERS: Solenoid-operated air valves function quickly and dependably for the control of gates, tilting tables, extractor cylinders on hot-strip coilers.





FOR ROLL BALANCE: Q. A. W. valves provide efficient and reliable control for hydraulic roll balance systems—lever-operated, 3-way, off-and-on exhaust action. Made for any pressure.

FOR FORGING PRESSES: Pilot-operated three- and four-way neutral action hydraulic valves for forging presses. Also used on slab pushers and manipulators.

FOR DESCALING: Designed specifically for descaling operations. A complete range of sizes from 1½ to 6 inches. Standard in the steel industry since 1935.

GENERAL PURPOSE AIR VALVES: Complete range of types and sizes of hand-operated air valves, in all popular actions for control of single and double acting air cylinders.

THE HIGHER THE PRESSURE
AIR
WATER
OIL
THE TIGHTER THE SEAL

C.B. HUNT & SON

Salem, Ohio

QUALIFIED FIELD ENGINEERS IN ALL PRINCIPAL STEEL MILL DISTRICTS

Fit for war service

With new motors hard to procure, it is doubly important to check up on those we have—to make sure they are fit for war service—continuous operation, overloads — without babying or tinkering.

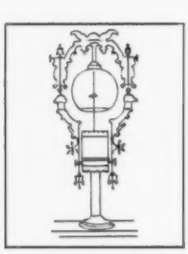
A good tonic for most motors that falter in strenuous service is a new set of brushes — not any set, but one chosen specifically for the job. Anybody can guess at what brush characteristics are best. Many will guess right.

More will guess wrong. Why guess? Get the scientific recommendation from SPEER — easy to get, no obligation involved. Merely do this: Ask for as many SPEER Brush Data Forms as you have motors you would like to improve. Return the completely filled in forms to SPEER. Back to you will speed recommendations based on forty years of commutation engineering. The rest is up to you. SPEER is ready to give this service freely to help speed production and total victory for freedom-loving peoples.

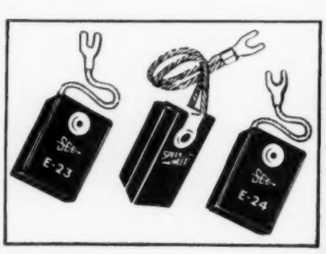
PROMOTE COPPER SALVAGE

Save the shunts and connections from discarded brushes. This helps to salvage copper needed for war material. Keep it moving to your salvage dealer as fast as it is accumulated.

Famous American Firsts



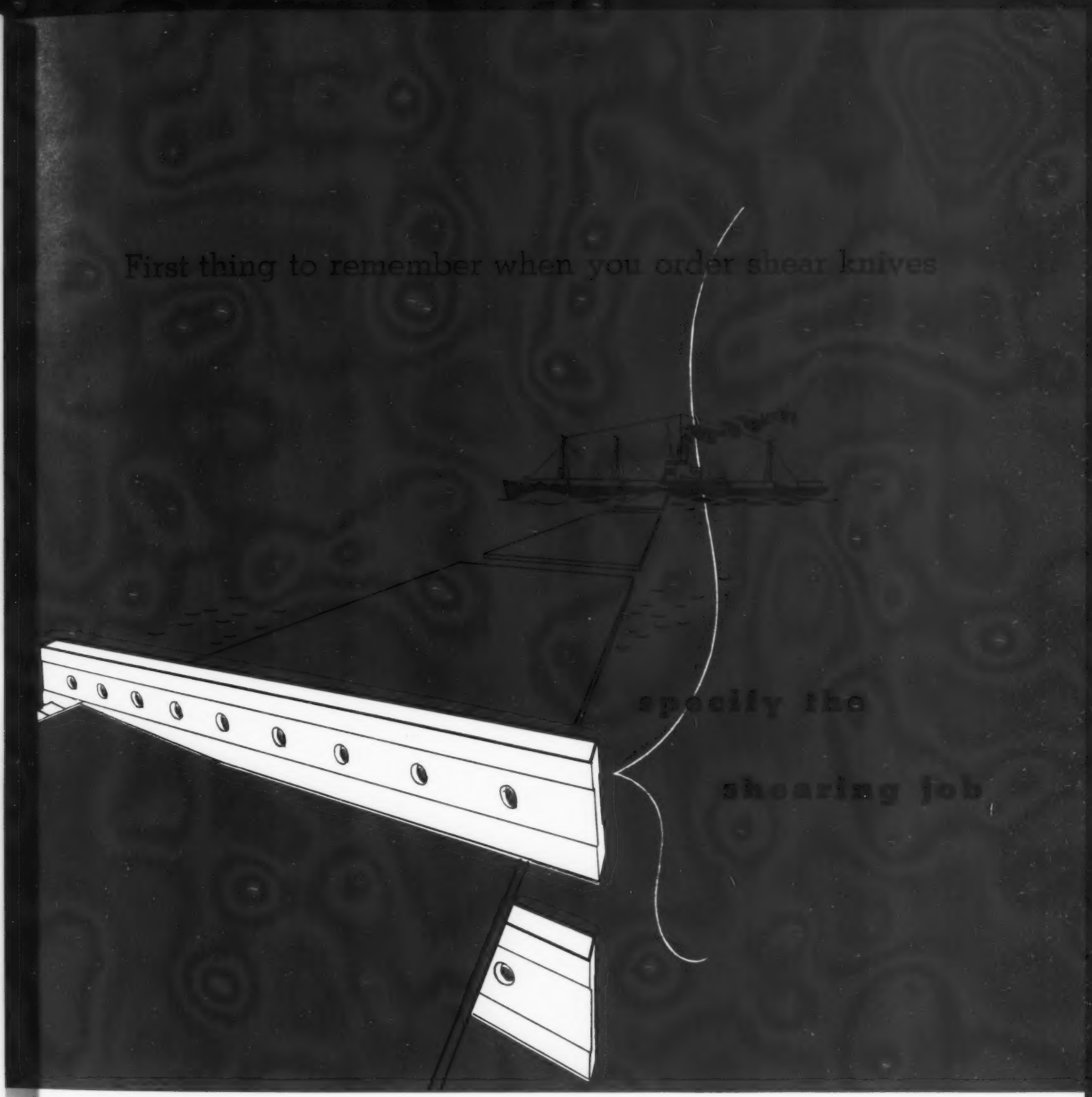
Arc Lamp, 1878



SPEER BRUSHES— To meet the requirements of most industrial motors, SPEER Electro-Graphitic Brush grades E-23 and E-24. Also available as Multiflex Brushes. Write today for complete descriptive catalog.
There is *one right* brush grade for every job—and SPEER makes it.

SPEER
CARBON COMPANY
ST. MARYS, PA.
CHICAGO · CLEVELAND · DETROIT
MILWAUKEE · NEW YORK · PITTSBURGH

3362



First thing to remember when you order shear knives is to specify their use. It's usually false economy to use a knife to cut a thickness or a steel for which it was not designed.

Second thing to keep in mind is delivery. Heppenstall facilities are extensive and we make our own E.I.S. Steel. We can deliver faster at a lower rating.

Third thing to keep in mind is quality. As the world's oldest and largest manufacturer of solid tool steel shear knives, Heppenstall is able to offer greater precision in manufacture.

Heppenstall

PITTSBURGH • DETROIT • BRIDGEPORT
EDDYSTONE

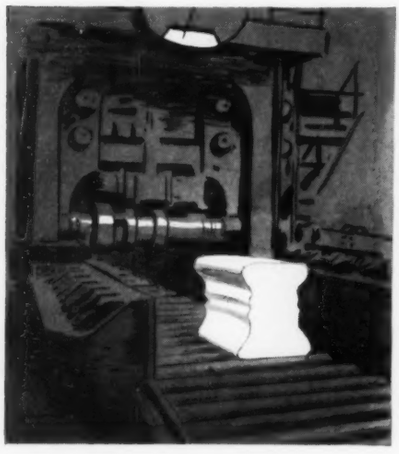
Forging Fine Steels for Fifty-Three Years

How Hagan Automatic Combustion Control Speeds Up Steel Making . . .

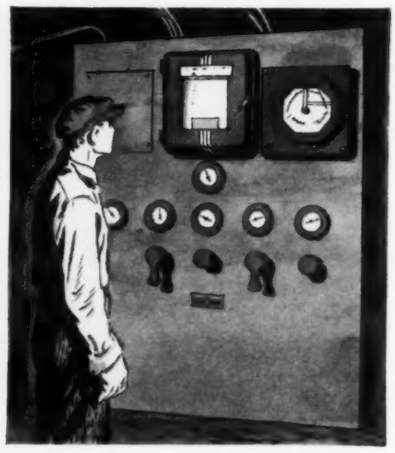
Blast furnace control. Controls air blown and makes for more uniform operation of furnace. Control of fuel-air ratio at stoves assures most efficient utilization of blast furnace gas. Makes more gas available for steam and power generation.

Open hearth control. Increases tonnage generally from 1% to 10% but some increases have gone as high as 22%. Cuts down heating time, produces more uniform steel. Permits firing with various fuels with fuel savings ranging consistently from 5% to 20%.

Soaking pit control. Increases tonnage and yield from 1% to 10%. Speeds up heating. Obtains more uniformly heated ingots. Reduces bottom making from once a day to once every week or two. Saves up to 20% fuel. Permits firing with various fuels.



More tonnage through rolling mill. Better, more uniform heating results in faster rolling with fewer rejects and better quality steel. Thus with Hagan Automatic Control on all important heating operations you speed up production all along the line.



Reheating furnace control. Increases tonnage through furnace 1% to 10%. Results in large fuel savings. One steel company saved $60,000 a year by arranging to burn the most economical fuels available at any given time.

HAGAN CONTROL PROVED IN ACTION

All Hagan Combustion Control for steel mill use has been thoroughly proved in service over a period of years. It is ruggedly designed for dependable operation in hot and dirty locations. It does not depend on delicate instruments for its action but is soundly engineered for severe service. Write for details on any type of combustion control you need. Hagan has a complete line for all heating applications.

HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

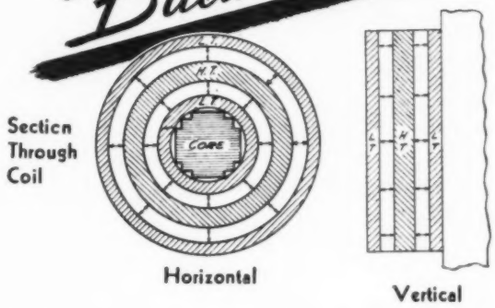
3,000 Kva,
3-Phase,
25 Cycles

Pennsylvania ASKAREL non-inflammable TRANSFORMERS

Like all Pennsylvania Transformers, ASKAREL Transformers are equipped with Circular Coils. In non-inflammable transformers there are many fundamental reasons why. . .

CIRCULAR COILS ...make the big difference

Balanced



The circular coil is practically balanced, radially and axially, against short circuit stresses.

When a transformer is subjected to heavy overload or short circuit, the circular coil maintains its shape even without the use of compound or varnish. By eliminating such stresses, the coil is not strained, and the insulation is not injured.

In regular oil cooled transformers, varnish is used to increase the mechanical and electrical strength of the transformer coils, irrespective of the shape of the coils. This kind of varnish, however, cannot be used to treat coils in a transformer where non-inflammable liquids are employed. Therefore, without the aid of this varnish, it is imperative that the coils in a non-inflammable transformer have *great inherent strength*.

CIRCULAR COILS POSSESS THE MAXIMUM INHERENT MECHANICAL AND ELECTRICAL STRENGTH.

1. In a circular coil the tension of each turn of wire is uniform throughout its length. No coil of any other shape possesses this quality.
2. The turns in a circular coil are wound tightly without excessive tension on the wire — thus eliminating the possibility of stretching the wire and injuring the insulation.

Pennsylvania *ASKAREL* Transformers offer you the convenience and economy of indoor installations near the load centers, plus the added safety inherent in the Pennsylvania circular coil construction.

Pennsylvania TRANSFORMER COMPANY
808 RIDGE AVENUE, N. S., PITTSBURGH, PA.

Even with a Green Operator–

You could start a green man every morning without a moment's worry over the safety of your bearings—

If they were protected by a Farval Centralized System of Lubrication.

With no expert attention Farval Centralized Systems will protect you in advance against disastrous shut-downs due to faulty lubrication. A few strokes of the Central Pumping Unit gives every bearing the amount of lubricant it requires and—not a bearing is missed.

Farval increases machine production hours. In less than one minute and while the equipment is in full operation, complete lubrication is obtained in perfect safety from the floor.

Farval enables you to return used equipment to profitable service. With bearings properly lubricated, even the older machines are able to carry the load.

Why not protect *your* equipment against the hazards of the Green Operator? Install Farval!

The Farval Corporation, 3278 East 80th St., Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Manufacturers of Automotive and Industrial Worm Gearing
In Canada: PEACOCK BROTHERS LIMITED

FARVAL
CENTRALIZED SYSTEMS OF LUBRICATION

WAGNER POWER TRANSFORMER

YOU CAN COUNT ON WAGNER

...for Dependable Transformer Performance

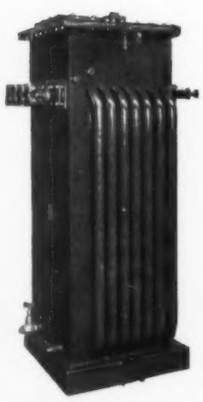
BUY U.S. WAR BONDS

In the steel industry, where production must be maintained at an all-time high to supply the enormous quantity of steel necessary to produce war equipment, dependable electric power is of major importance.

The transformers are the vital links in any electric power distribution system. If the transformers fail, unsatisfactory service results – production is delayed and operating costs go up.

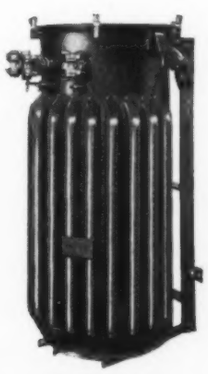
Wagner Transformers have established outstanding records in the steel industry for continuous service and long life. Carefully controlled production methods, highest quality materials, rigid inspection and tests, plus 50 years of transformer engineering experience, are just a few of the reasons why you can count on Wagner for dependable transformer performance.

Wagner can take care of all of your transformer requirements. 25 branch offices, located in as many principal cities and manned by trained field engineers, are always ready to help you.



WAGNER NOFLAMOL TRANSFORMER

WAGNER AIR-COOLED TRANSFORMER



WAGNER HEX TRANSFORMER

T42-11

Wagner Transformer Features:

Liberal insulation—extra end turn insulation provides added protection against line surges and voltage disturbances . . . Heavy tank construction—heavy steel plate, electrically welded, sand-blasted and flow-painted . . . Core iron of non-aging silicon steel—has high magnetic permeability and has very low hysteresis and eddy-current losses . . . Tap changer contacts of low resistance and with high over-current capacity, securely held in place and accurately aligned . . . Bushings—wet-processed porcelain, either solid or oil-filled, with ample mechanical and electrical strength to withstand stresses encountered in service . . . Transformer Oil—has high dielectric strength, proper viscosity, safe flash-point, and resistance to sludging.

Complete Information sent on Request

Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

TRANSFORMERS • MOTORS • FANS • BRAKES

For Economical Material Handling

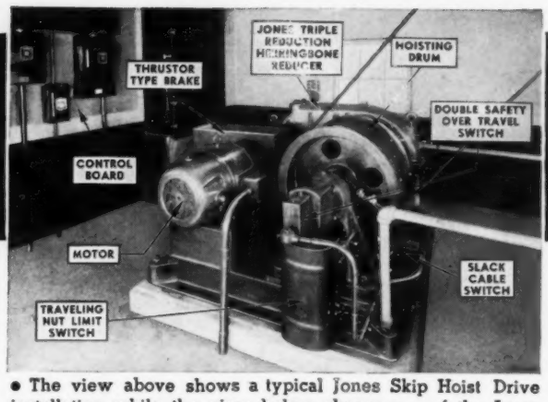
JONES SKIP HOIST DRIVES

FOR speedy operation, reliable service and over-all economy the Jones Skip Hoist Drive has made a name for itself in a wide variety of material handling service. These skip hoist drives are built as complete units by the Jones organization in several types with base to take any motor specified by the purchaser. They are equipped for all the modern protective devices such as cam or nut type limit switches, solenoid or disc type brakes and slack cable switches. The drives are single, double, or triple reduction Jones Herringbone Speed Reducers, built to stand up under the many years of pounding that a skip hoist drive has to take. The shafts are supported in roller bearings, with rolling action, rack generated gear and pinion teeth to insure easiest possible starting with low starting-peak loads. All reducer bearings and gears are automatic oil-bath lubricated.

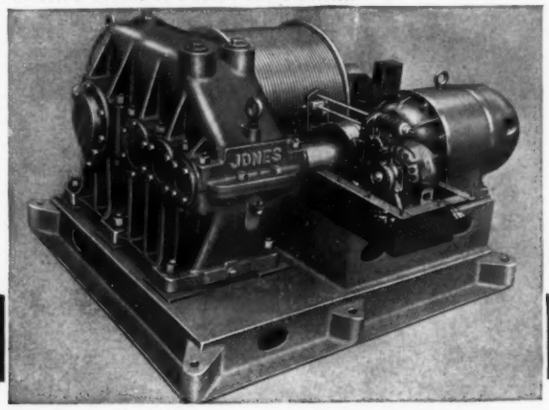
The Jones organization has an extensive file of information on skip hoist drive problems and will be pleased to work with you on any problems involving such applications

W. A. JONES FOUNDRY & MACHINE CO.
4431 Roosevelt Road, Chicago, Illinois

Jones
HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS
CUT AND MOLDED TOOTH GEARS • V-BELT SHEAVES
ANTI-FRICTION PILLOW BLOCKS • PULLEYS
FRICTION CLUTCHES • TRANSMISSION APPLIANCES



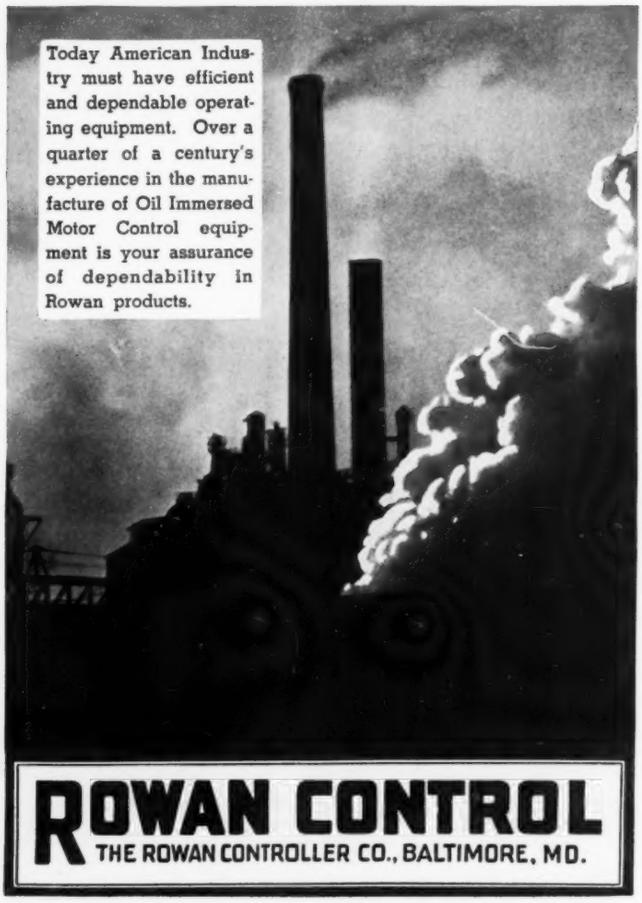
• The view above shows a typical Jones Skip Hoist Drive installation while the view below shows one of the Jones units equipped with traveling nut type limit switch, motor actuated brake, and slack cable switch.



ROWAN
Oil Immersed
MOTOR CONTROL

BY USERS EVERYWHERE

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.



Today American Industry must have efficient and dependable operating equipment. Over a quarter of a century's experience in the manufacture of Oil Immersed Motor Control equipment is your assurance of dependability in Rowan products.

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

INDEX TO ADVERTISERS

A

Aetna-Standard Engineering Company 1
Air Reduction Sales Company 131
American Hammered Piston Ring Division of Koppers Company 100-101
Amsler-Morton Company 16A

B

William M. Bailey Company 119-120
Bartlett-Hayward Division of Koppers Company 100-101
Bloom Engineeing Company 15
Bonnot Company 12
Broden Construction Company 16B, 16C

C

Clark Controller Company 126
Cleveland Crane and Engineering Company 2
Continental Roll and Steel Foundry Company 97
Crouse-Hinds Company 116
Cutler-Hammer, Inc. ..... Cover 2

D

De Laval Steam Turbine Company 10

E

Edison Storage Battery Division Thomas A. Edison, In. 11
Electric Controller and Manufacturing Company 13
Electric Storage Battery Company 5
Engineering and Construction Division of Koppers Company 100-101

F

Farrel-Birmingham Company, Inc. 117
Farval Corporation 142
Flinn and Dreffein Company 16B, 16C

G

Gas and Coke Division of Koppers Company 100-101
Gatke Corporation 123
General Electric Company ..... Cover 4

H

Hagan Corporation 140
Hallden Machine Company 16B, 16C
Hays Corporation 121
Heppenstall Company 139
C. B. Hunt and Son 137
Hyatt Bearings Division General Motors Corporation 65
Hydropress, Inc. 7

I

I-T-E Circuit Breaker Company ..... Cover 3

J

Johns-Manville 41
W. A. Jones Foundry and Mahine Company 144

K

C. M. Kemp Manufacturing Company 118
Koppers Coal Company 100-101
Koppers Company 100-101
Koppers Rheolaveur Company 100-101

L

Leeds and Northrup Company 4
Lewis Foundry and Machine Division Blaw-Knox Company 16
Linde Air Products Company 134
Loftus Engineering Corporation 45

M

Mackintosh-Hemphill Company 129
Maryland Drydock Company 100-101
Mathews Conveyer Company 24
James H. Matthews and Company 124
McKay Machine Company 16D
Mesta Machine Company ..... Cover 1
Morgan Construction Company 125
Morgan Engineering Company 146

N

National Bearing Metals Company 124
National Carbon Company, Inc., Carbon Sales Division 99
National-Erie Corporation 136
National Roll and Foundry Company 45
New York and New Jersey Lubricant Company 147
Norma-Hoffmann Bearings Corporation 148
North American Manufacturing Company 17

O

Ohio Electric Manufacturing Company 147
Okonite Company 8

P

Pennsylvania Transformer Company 141
Pittsburgh Lectromelt Furnace Corporation 28
Pittsburgh Rolls Division Blaw-Knox Company 20
Poole Foundry and Machine Company 98
Post-Glover Electric Company 6

R

Ready-Power Company 132
Reliance Electric and Engineering Company 133
Rockbestos Products Corporation 75
Rowan Controller Company 144

S

SKF Industries, Inc. 22, 23
Socony-Vacuum Oil Company, Inc. 9
Speer Carbon Company 138
Streine Tool and Manufacturing Company 128

T

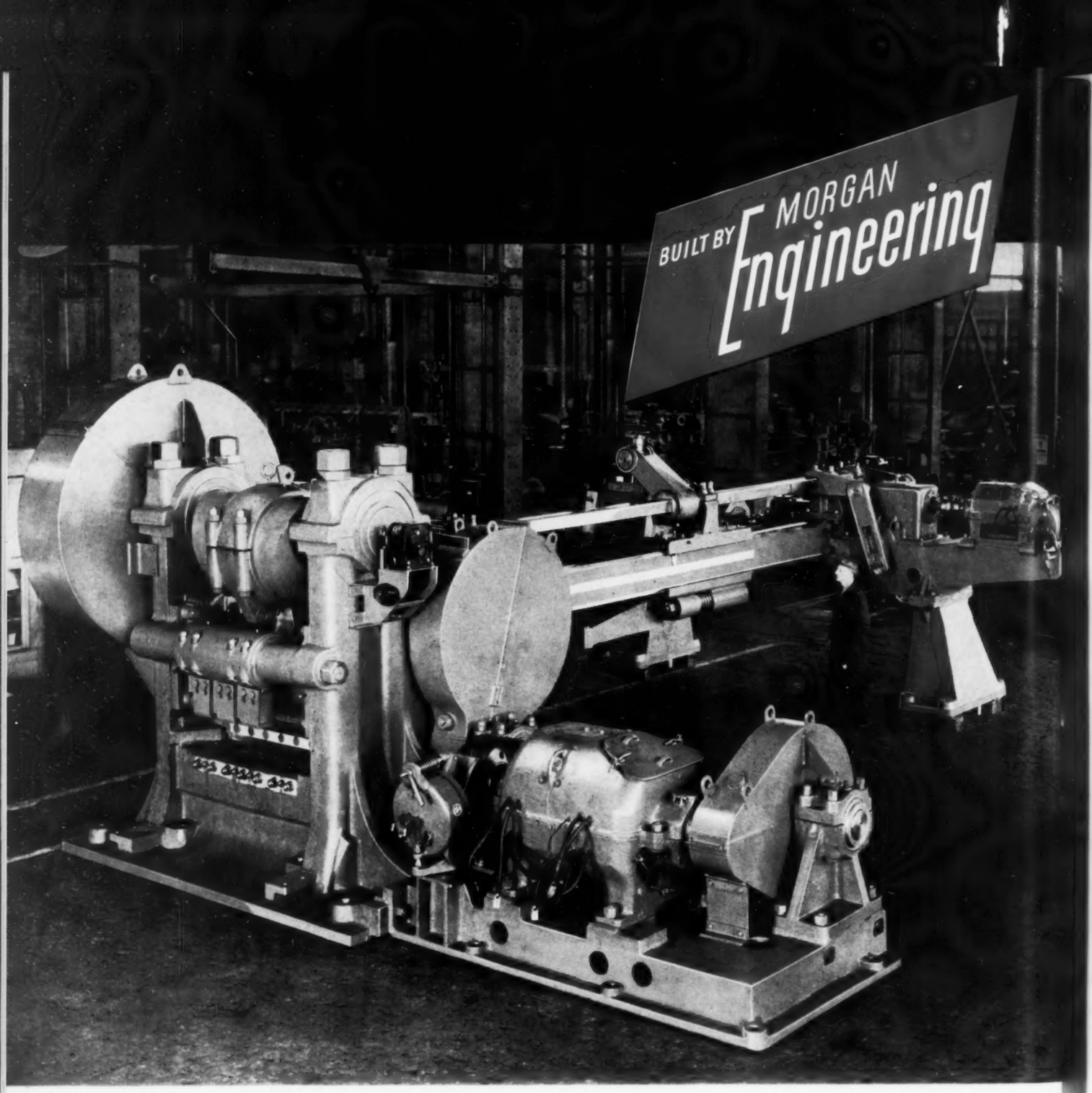
Tar and Chemical Division of Koppers Company 100-101
Timken Roller Bearing Company 127
Truflo Fan Company 135

U

Union Carbide and Carbon Corporation 99-134
United Engineering and Foundry Company 18, 19

W

Wagner Electric Corporation 143
Wean Engineering Company, Inc. 16B, 16C
Wean Engineering Company of Canada, Ltd. 16B, 16C
Wellman Smith Owens Engineering Corporation, Ltd. 16B, 16C
Western Gas Division of Koppers Company 100-101
Westinghouse Electric and Manufacturing Company 21
White Tar Company of New Jersey, Inc. 100-101
Wood Preserving Corporation 100-101



MORGAN 450-TON BLOOM AND SLAB SHEAR

● Among the many types of mill equipment built by Morgan, is the 450-Ton Bloom Shear illustrated above for shearing 12″ x 12″ blooms and equivalent slab sections. Shear is designed without flywheel or clutch for start and stop operation. Hold-down gag is of the independent hand adjusted type. A motor operated gauge is provided for gauging lengths from 2′0″ to 15′0″. Of massive construction, this shear is typical of the types of mill equipment Morgan designs and builds.

THE MORGAN ENGINEERING CO.
ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES SPECIAL MACHINERY FOR STEEL MILLS

Keep All Motors Working For "All Out" Production

You must prevent loss of production caused by motors down for repairs. This means oil is "out"— because it leaks from bearings, gets on windings, and causes "burn-outs".

Such troubles disappear when you use drip-less, waste-less

TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT. OFFICE & FOREIGN COUNTRIES

MODERN STEEL MILL LUBRICANT

This product stays in bearings and off windings, outlasts oil, cuts lubrication cost ½ or ⅓ — keeps motors in constant service.

Used successfully in leading iron and steel mills. Send for instructive bulletin.

•

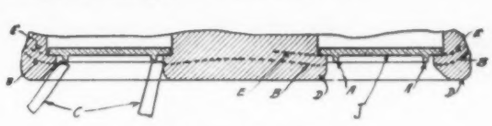
New York & New Jersey Lubricant Co.
Main Office: 292 Madison Ave., New York, N. Y.
WAREHOUSES:
Chicago, Ill. — Atlanta, Ga.
St. Louis, Mo. — Detroit, Mich.
Providence, R. I. — Greenville, S. C.

Better Lubrication at Less Cost per Month

Ohio Magnet Outer Rings Seldom Break

The bottom or wearing face of an Ohio Magnet presents a solid long lived surface to the work.

The annular rings on the manganese bottom plate prevent dangerous wear of steel pole shoes, so bottom plate cannot sag. See cut below.



Note wear line B B B

There are no holes or depressions to start wear or cracks.

These features result in
LOW MAINTENANCE COST.

OHIO reliable MAGNETS

The OHIO Electric Mfg. Company
5907 Maurice Avenue
Cleveland · · Ohio

SOLDIERS OF STEEL
ON 24-HOUR DUTY
Day and night, pausing only for changes, repairs or maintenance, countless thousands of machine tools — "Soldiers of Steel" in the army of production — are turning out armament, equipment and supplies, that Victory may be hastened. For them, there is no rest, no relaxing of effort. They must "keep on the job".
In thousands of these tools, built by practically every representative machine tool manufacturer, NORMA-HOFFMANN PRECISION BEARINGS are "standing the gaff" of this continuous service—and contributing accuracy, rigidity, speedability and dependability under the most gruelling conditions ever imposed upon machines.
The counsel of our engineers, with 30-odd years of experience in bearing application and maintenance, is yours on request—without obligation.
"NORMA-HOFFMANN"
PRECISION BEARINGS
BALL, ROLLER AND THRUST
NORMA-HOFFMANN BEARINGS CORP'N., STAMFORD, CONN. . . . FOUNDED 1911

TYPE ET-20 *Thermal* Circuit Breakers

Do you know how useful TYPE ET-20 is?

With main feeder distribution circuits heavily loaded as they now are, there is need for high interrupting capacity. Type ET meets this need with

interrupting rating of 25,000 amperes.

FIG. 1

Changeovers in industrial operations call for flexibility in the current ratings of circuit protective devices. For this need, the Type ET circuit breakers have

interchangeable trip units

with continuous ratings ranging up to 600 amperes. Trip units are very easily changed.

To meet a variety of requirements, Type ET-20 circuit breakers are available with

undervoltage trip and shunt trip

Provision is made for auxiliary switches with one "a" and one "b" contact and overcurrent bell alarm switches.

Avoidance of needless power interruption was never more important than it is now. Inherent time-delay incorporated in Type ET-20, permits continuous service unaffected by harmless overloads. Tripping mechanisms have true

inverse-time characteristics

—the greater the need for opening the circuit, the more quickly it is accomplished. Heavy overloads and short circuits trip the breaker instantaneously.

Type ET-20 circuit breakers are extremely compact. Over-all case dimensions are 19½ x 9 x 6 inches.

Space is saved.

Design of the Type ET-20 provides maximum ruggedness with minimum material.

Critical materials are saved.

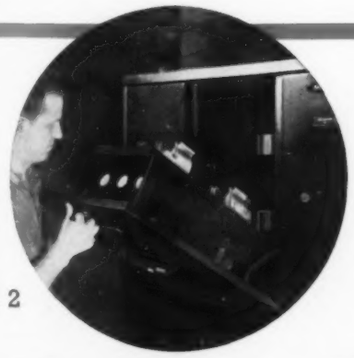


FIG. 2

Type ET-20 circuit breakers, shown in Fig. 2 mounted in a withdrawal type switchboard and in Fig. 3 in an individual steel enclosure, are installed in main feeder distribution circuits, up to 600 volts a-c and 250 volts d-c. They are accurately calibrated at the I-T-E factory. They serve with a very minimum of maintenance.

FIG. 3

I-T-E

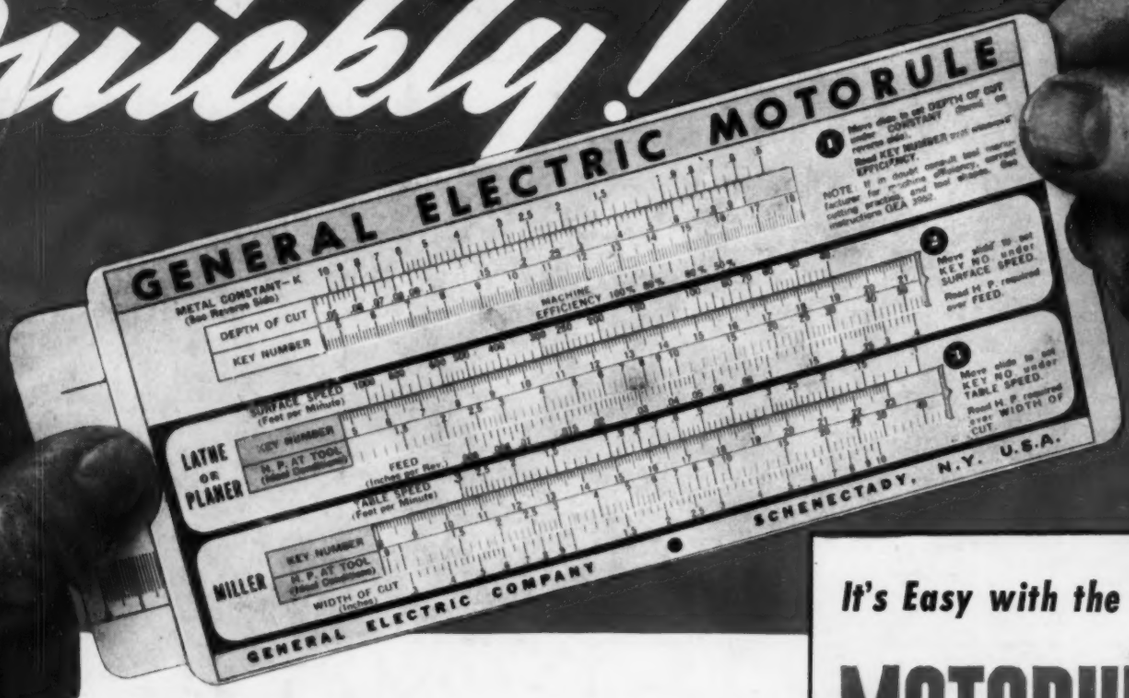
AIR SWITCHGEAR

IMMERSED IN AIR — ENCASED IN STEEL

The Army-Navy "E" for Production Excellence

CIRCUIT BREAKER CO., PHILADELPHIA, PA.

FIND METAL-CUTTING HORSEPOWER Quickly!



This newly developed load calculator makes it easy to figure the motor horsepower required for metal-cutting operations when the recommendations of the machine builder are unavailable. Its advantages? You can avoid *undermotoring* and save yourself production delays; you can avoid *overmotoring* and save the nation vitally needed steel, copper, and aluminum.

The G-E MOTORULE is accurate for a wide variety of cutting operations on lathes, drills, milling machines, and planers. It works on a wide range of materials, because you start from a convenient table of constants for the material being cut.

The results of many years of work by metal-cutting authorities were used by G-E engineers as a basis for the MOTORULE. The formulas were checked against actual load tests, and leading machine-tool builders were consulted.

The MOTORULE will help you in making sure of adequate motor capacity on machines being put to new war work, and in selecting motors for machines formerly driven from line shafting. To get your MOTORULE, just get in touch with your G-E Motor Representative. Or, if you wish, mail the coupon direct to General Electric, Schenectady, N. Y.

It's Easy with the G-E

MOTORULE*

First you refer to a convenient table of constants, printed on each rule, choosing the constant for the particular type of metal to be cut. Then by setting the scales to the known cutting speed, feed, and cut, you arrive at the cutting power required on the basis of ideal tool and machine conditions. Complete instructions are furnished with each MOTORULE.

*The MOTORULE is not intended to supplant the instructions of machine builders as to the power requirements of their machines. It is offered to fill the gap when these recommendations are unavailable.

SPECIFY TRI/CLAD MOTORS

REG. U.S. PAT. OFF.

Standard G-E Motors Are Generally Available without Delay for War Jobs

The Navy "E", for Excellence, has been awarded to 92,780 General Electric employees in six plants manufacturing naval equipment.

GENERAL ELECTRIC

General Electric Co., Sec. C 750-159
Schenectady, N. Y.

☐ Please send your MOTOR FITNESS MANUAL, GED-1017.

☐ Please send me a G-E MOTORULE, with full instructions and leaflet giving the principles on which it is based.

Name.....

Title.....

Company.....

Street.....

City..... State.....